From:	Quinones, Edwin
To:	Talton, Chuck
Cc:	Shewmake, Kenneth
Subject:	FW: Star Lake Canal Site; SLCCP"s Response to BP/Total"s CDM Report
Date:	Tuesday, December 11, 2018 5:10:05 PM
Attachments:	SLCCP REBUTTAL to BP and Total CDM Report (Final).pdf - Adobe Acrobat Pro (2).pdf BP-TOTAL Letter Figures Complete 9-10-18 11 x17 size.pdf

Hi Chuck,

I don't have a CD-ROM driver on my laptop and am wondering if you could please copy the attachments to Ms. Bryan's email onto two CD-ROMs. The CD-ROMs will be included as enclosures to the letters I intend to send to each counsel for BP and Total, respectively.

Thanks,

Ed Q.

From: Connie Bryan <cbryan@mccormickbryan.com>
Sent: Monday, September 10, 2018 5:06 PM
To: Quinones, Edwin <quinones.edwin@epa.gov>
Subject: Star Lake Canal Site; SLCCP's Response to BP/Total's CDM Report

Ed:

Pursuant to my phone call last week, please see the attached. Do not hesitate to contact me with any questions.

Regards,

Connie

PLEASE NOTE OUR NEW ADDRESS

MCCORMICK & BRYAN, PLLC
2011 W. Danforth Rd., #135
Edmond, OK 73003
Telephone (405) 562-6800
Facsimile (405) 643-7015
Cell: 405-625-6395
cbryan@mccormickbryan.com

McCORMICK & BRYAN, PLLC
ATTORNEYS AT LAW

cbryan@mccormickbryan.com

VIA E-MAIL AND USPS PRIORITY MAIL

September 10, 2018

Mr. Ed Quinones, Esq.
Regional Counsel
U.S. Environmental Protection Agency-Region 6
1445 Ross Avenue
Dallas, Texas 75202

Dear Mr. Quinones:

On behalf of the Star Lake Canal Cooperating Parties (SLCCP), thank you and your team for meeting with us on March 14, 2018. We found the meeting productive and hope you and your team found it informative. As you know, the genesis of that meeting was the presentation developed by CDM Smith Inc. (CDM Smith) on behalf of both Total Petrochemicals & Refining USA, Inc. and BP America Inc. (collectively BP/Total or the Companies). The SLCCP is now in receipt of a written submission to USEPA (CDM Smith Report) that further outlines the position of the Companies. This letter provides the SLCCP's response to CDM's presentation and the CDM Smith Report.

Specifically, this response establishes that: 1) BP/Total discharged wastes to the Molasses Bayou throughout the 80-plus year operating timeframe of the BP/Total Port Arthur Refinery (BP/Total Refinery); 2) the Right Prong of the Molasses Bayou (Right Prong) served as a transport pathway to the Star Lake Canal Superfund Site (Site) for a portion of such discharged wastes; and 3) chemical analyses establish that the BP/Total Refinery is the likely source of certain contamination at the Site. The rebuttal analysis below highlights the numerous flaws in the Companies' analysis and supports a determination that BP and Total are responsible parties for the Site.

1. Executive Summary

BP/Total's arguments fail to refute their liability for response costs at the Site. While the SLCCP has issues with most, if not all, of the points and data interpretations in the CDM Smith Report, we focus this response on the fatal flaws in their analysis of the three key areas: Historical Discharges; Hydrology and Sediment Transport Capacity; and Analytical Data/Chemistry.

Historical Discharges Analysis

BP/Total inaccurately assert in the CDM Smith Report that, starting with the installation of the Boat Canal ~1930, the Right Prong has been a severely diminished sediment transport pathway and is continuing to diminish.

As provided herein, the SLCCP rebuts BP/Total's assertion regarding Historical Discharges based on the following facts:

1. The BP/Total Refinery is documented to have discharged wastes over its 80-plus year operating timeframe to the Molasses Bayou and wetlands proximate to the BP/Total Refinery.

2. Effluent (e.g., process and storm water) containing hazardous substances was discharged from the BP/Total Refinery at multiple outfalls (e.g., Outfalls 001 and 002, Accelator outfall, North Ditch, Separator Canal, Boat Canal, and petrogas plant outfall) and likely from an area now known as SWMU 2 - the North Flare Landfill, all of which are documented in regulatory files or the Companies' records.

Hydrology and Sediment Transport Capacity Analysis

BP/Total wrongly assert that the Right Prong drains towards the Boat Canal and that there is evidence of diminishing sediment transport capacity towards the Site.

The SLCCP rebuts BP/Total's assertions regarding Hydrology and Sediment Transport Capacity based on the following facts:

3. The Right Prong served as a transport pathway to the Site over time for a portion of wastes discharged from the multiple point sources at the BP/Total Refinery. This pathway existed both prior to and after construction of the hurricane protection levee.

4. Molasses Bayou and the surrounding wetlands area are highly influenced by tidal action and flow both to and from the BP/Total Refinery allowing wastes to be transported to the Site. This bi-directional flow is supported by flow and water level data provided in the CDM Smith Report, tide gauge information at Rainbow Bridge, and oil recovery boom deployment by BP/Total designed in an attempt to protect Molasses Bayou from releases from the BP/Total Refinery. In addition, SLCCP herein presents conservative hydraulic modeling of releases to the Boat Canal that demonstrate a connection to the Site.

5. There is no evidence of diminishing sediment transport from the BP/Total Refinery to the Site. The formation of open-water areas within the site is predominately due to natural processes such as wind driven erosion and inundation.

Analytical Data/Chemistry Analysis

BP/Total incorrectly assert that a comparison of chemical concentrations between the Site Remedial Investigation (RI) and RCRA-required investigations of the Refinery Solid Waste Management Unit (SWMU) 8 and SWMU 11 do not indicate that the Refinery is the source of contaminants present in Site sediments. Additionally, BP/Total misleadingly assert that benzo(a)pyrene, polychlorinated biphenyl (PCB)-126, and total polycyclic aromatic hydrocarbon (PAH) concentrations at the historical confluence of the Right Prong and Left Prong of Molasses Bayou (Left Prong) (i.e., in the location of MB-56) do not indicate that the BP/Total Refinery is the source of contamination in Site sediments.

As provided herein, the SLCCP rebuts BP/Total's assertions regarding Analytical Data/Chemistry Analysis based on the following facts:

6. The chemical composition of PAH in Molasses Bayou differs from upstream PAH, thus suggesting a separate source of PAH to Molasses Bayou. This is supported by PAH spatial concentration patterns as well as by the presence of elevated TPH and BTEX in Molasses Bayou sediments.

7. Polychlorinated biphenyl (PCB) chemical composition patterns in the Left Prong of Molasses Bayou are distinctly different in the vicinity of and downstream from the historic intersection of the Right Prong (i.e. near station MB-56) indicating a likely BP/Total Refinery source of PCB to the Molasses Bayou.

In summary, BP/Total discharged wastes to the Molasses Bayou throughout the 80-plus year operating timeframe of the BP/Total Refinery. Without a doubt, the Molasses Bayou served as a transport pathway to the Site for a portion of these wastes discharged by BP/Total. Further, chemical analyses establish that the BP/Total Refinery is the likely source of certain contamination at the Site. These lines of evidence show a definite nexus between the BP/Total Refinery and chemicals of concern at the Site and, therefore, clearly establish that both BP and Total have liability for response costs at the Site.

2. Historical Discharges Analysis Rebuttal

There is substantial evidence that waste discharges from the BP/Total Refinery to the marsh (between the BP/Total Refinery and Neches River) and the Molasses Bayou occurred both prior to and after construction of the hurricane protection levee.

CDM Smith's discussion in Section 4.1.1 of the CDM Smith Report is misleading, as it infers that the pre-levee construction outfall discharges (1936 -1972) were benign and not a significant potential contributor to contamination. As discussed in the BP/Total nexus summaries and supplemented below, prior to the construction of the hurricane levee circa-1973 to 1978, the BP/Total Refinery had multiple waste disposal outfalls and one waste disposal impoundment area that discharged to the Molasses Bayou and marsh area proximate to the BP/Total Refinery.[1] As documented in regulatory files and the Companies' records, these waste disposal features discharged BP/Total Refinery wastes as follows:

1. Outfall 1 (aka Country Club Ditch, Outfall A, and Outfall 001) - discharged process and storm water effluent from the BP/Total Refinery to the swamp/marsh (i.e., wetlands adjacent to the BP/Total Refinery). The BP/Total Refinery's Demineralization Unit, which alternated between diluted sulfuric acid and diluted sodium hydroxide, discharged to the marsh.[2]
2. Outfall 2 (aka Outfall B and Outfall 002) - discharged wastes from the BP/Total Refinery to the swamp/marsh (i.e., wetlands adjacent to the BP/Total Refinery), combined with BP/Total Refinery wastes from the Accelator Outfall, and transported those wastes to the North Ditch. The Accelator

[1] Outfalls 1, 2, and 3 were sometimes referred to as Outfalls A, B, and C in regulatory files.

[2] Marshall Elliott and Larry Smaihall, Atlantic Richfield Refining Co., Industry Survey, November 1, 1967; BP Corporation, Industrial Wastewater Discharge Permit No. 00491, ca. 1969.

Outfall contained practically all the oily wastes from the BP/Total Refinery, and those wastes joined with Outfall 2 wastes which were then carried to the North Ditch.[3] Oily wastes discharged to the North Ditch, which was an unlined conveyance feature, would have saturated and percolated into ditch bottom soils and the area surrounding the feature. Further, while there was a flume that conveyed the oily waste water over the Bayou, during periods of significant rainfall, the ditch and flume would have become inundated and overflowed into the adjacent wetlands.[4] Construction of an API separator began in 1968, and an equalization basin was constructed on the location of the separator pit in 1970. A consultant working for ARCO stated that when the equalization basin was built it was likely that contaminated soils were pushed out of the separator pit to the edge of the marsh.[5] When American Petrofina closed the API separator in 1987, its' consultant discovered a layer of contaminated soil (lead and naphthalene) approximately two feet deep at four-to-six feet below ground surface.[6]

3. Outfall 3 (aka Outfall C and Outfall 003) - discharged treated process waste streams from the BP/Total Refinery through a 24-inch pipe to the Boat Canal and then to the Neches River.[7] Since its inception, the Boat Canal was connected to the Right Prong, and process waste waters could flow freely (except during periods when booms were deployed) from the Boat Canal to Molasses Bayou. Further, aerial photographs confirm that tidal flows to and from Molasses Bayou would have influenced waste water flows from the Boat Canal to Molasses Bayou. The average effluent was 3M/GPD.[8]

Prior to the construction of the hurricane levee, wastewater from these features discharged to the North Ditch and Accelator Outfall/Separator Canal and the marsh area. Attached Figures 1 and 2 show pre-levee BP/Total Refinery discharge pathways. CDM Smith provides an historical overview of the BP/Total Refinery outfalls from 1936 to the present in the CDM Smith Report. In doing so, CDM Smith uses an aerial image from 1970 to support its assertions relating to the pre-1970 discharges from the BP/Total Refinery outfalls. CDM Smith states that from 1936 through the early 1970s, the BP/Total Refinery's treated process water "was conveyed to and discharged directly to the Neches River."[9] CDM Smith states that the discharge was supposedly conveyed from the Site to the Neches River via the Separator Canal. However, Figure 3-5a of the CDM Smith Report, which is dated December 31, 1937, does not depict the Separator Canal.[10] Moreover, Fina's 1992 Work Plan for the unlined Separator Canal

[3] Marshall Elliott and Larry Smaihall, Atlantic Richfield Refining Co., Industry Survey, November 1, 1967.
BP Corporation, Industrial Wastewater Discharge Permit No. 00491, ca. 1969.

[4] Jones & Neuse, Inc., RCRA Facility Investigation Phase 1 Work Plan for the Separator Canal, March 1996, p. 2.

[5] Retech, "Summary of Past Waste Management at the American Petrofina Refinery, Port Arthur, Texas," May 1989, p. 4.

[6] Retech, "Summary of Past Waste Management at the American Petrofina Refinery, Port Arthur, Texas," May 1989, pp. 1 and 10.

[7] BP Corporation, Industrial Wastewater Discharge Permit No. 00491, ca. 1969.

[8] BP Corporation, Industrial Wastewater Discharge Permit No. 00491, ca. 1969.

[9] CDM Smith Report, July 24, 2018, p. 4-1 and Figure 4-1b.

[10] CDM Smith Report, July 24, 2018, Figure 3-5a.

(revised to 1996), which conveyed the treated process water to the Neches River, shows that the Separator Canal was not built until the early 1940s.[11] These facts appear to contradict CDM Smith's assertions that from 1936 to the early 1970s, the BP/Total Refinery's treated process water was discharged directly to the Neches River. Further, prior to the construction of the Separator Canal, process wastewater appears to have been discharged from the BP/Total Refinery to both the swamp/marsh area and to Boat Canal upstream of the Right Prong, thus allowing process wastewater to enter the Molasses Bayou Channel and the swamp/marsh.[12] Attached Figure 3 depicts BP/Total Refinery discharge locations prior to the construction of the Separator Canal. In 1955, an Accelator was installed as a part of the BP/Total Refinery's waste processing system. After passing through the Accelator, treated wastewater was discharged to the Separator Canal. However, during upset conditions, this discharge was routed to the Boat Canal at a point upstream of the Right Prong, again allowing BP/Total Refinery wastewater to enter directly into Molasses Bayou.[13]

According to CDM Smith, between 1972 and 1983, the BP/Total Refinery had another outfall, Outfall 006, located in the Boat Canal near the connection with the Right Prong.[14] Attached Figure 4 shows the location of Outfall 006. CDM Smith does not appear to identify the source of the discharge for this outfall, nor did Total provide Discharge Monitoring Reports for Outfall 006 as part of its March 13, 2018, 104(e) submission to the USEPA (as it did for the other five BP/Total Refinery outfalls for the years 1978-1983).[15]

In addition to the BP/Total Refinery outfalls, waste disposal cells located on the northeastern portion of the BP/Total Refinery operated from approximately the early 1950s until the 1970s. This area was used for the disposal of tank bottoms and air flotation sludge and was connected to the Molasses Bayou. This disposal area is now referred to as the SWMU 2 North Flare Landfill.[16] It was reportedly constructed with clay liners.[17] The disposal cells extended into the swamp/marsh area and appear to have transported flows via a ditch to Molasses Bayou. Attached Figure 5 shows the location of SWMU 2 North Flare Landfill and its proximity to the Right Prong.

---

[11] Jones & Neuse, Inc., RCRA Facility Investigation Phase 1 Work Plan for the Separator Canal, March 1996, pp. 2 and 8.

[12] Jones & Neuse, Inc., RCRA Facility Investigation Phase 1 Work Plan for the Separator Canal, March 1996, pp. 15.

[13] CDM Smith Report, July 24, 2018, pp. 4-1 and 4-2.

[14] CDM Smith Report, July 24, 2018, p. 4-2 and Figure 4-2b.

[15] CDM Smith Report, July 24, 2018, p. 4-2; For the Discharge Monitoring Reports see TPRISL000893 through TPRISL001340.

[16] The waste disposal cells were operated until the construction of the Hurricane Levee. The North Refinery Flare and its related piping was installed directly over the former disposal area in 1983. See, ENSR Prepared for Atofina Petrochemicals, Inc. December 2002. Risk Reduction Rule Standard 3 Closure Corrective Measures Implementation Plan SWMU 2- North Flare Landfill. Document Number 05370-030-510ENSR, p. 1-1.

[17] ENSR Prepared for Atofina Petrochemicals, Inc. December 2002. Risk Reduction Rule Standard 3 Closure Corrective Measures Implementation Plan SWMU 2- North Flare Landfill. Document Number 05370-030-510ENSR, p. 1-1.

In October 1962, the United States Congress approved the Port Arthur and Vicinity Hurricane Flood Protection project. The project called for the construction of 34.4 miles of levee, several pumping stations, and drainage structures that would relieve hurricane flood waters if they reached beyond the levee walls.[18]

By 1975, the hurricane levee construction had altered the configuration of the waste disposal cells, and a portion of the BP/Total Refinery's waste pond area remained in the marsh.[19] Attached Figure 6 depicts the location of the disposal cells in relation to the levee based on information acquired from the United States Army Corps of Engineers (USACE). It also depicts the discharge point from the disposal cells area to Molasses Bayou. Attached Figure 7 shows the location of the former waste pond area outside the hurricane levee.

Between September 1964 and October 1974, in preparation for the levee construction, the USACE collected and analyzed soil borings proximate to the path of the proposed levee.[20] Generally, the USACE found petroleum waste product which would have come from the BP/Total Refinery in the top two to three feet of material in the marsh between Station No. 111+00 to Station No. 149+00 and Station 168+00 and Station 174+00.[21] Sample locations 3ST-1067, 6ST-335, HA-335A, and HA-449A had petroleum waste in the first foot of soil below ground level.[22] Attached Figure 8 shows the USACE sample locations where petroleum waste was detected.

The construction of the levee altered the drainage patterns discharging from the BP/Total Refinery. The USACE documented its work with a Design Memorandum produced for each segment. The area of interest near the BP/Total Refinery falls under Design Memorandum No. 2 Supplement No. 3 (DM No. 2-3).[23] DM No. 2-3 indicated that the agency "assumed that the very soft waste material…will displace under the embankment load," including the "very soft petroleum waste material" in some areas of the swamp/marsh.[24] In fact, the USACE recommended in an indorsement to DM No. 2-3 that the specifications for the levee should "provide adequate control over the contractor's operations to insure that the very soft materials are displaced beyond the boundaries of the levee."[25] Once the levee was built and

[18] USACE, Draft: Environmental Statement, Port Arthur Hurricane Flood Protection Port Arthur and Vicinity, Texas, August 29, 1973, pp. i and 1.

[19] USACE, Port Arthur, Texas, Levee: Second State Construction, STA. 65+70 to STA. 206+50, November 1974, Drawing 3.

[20] Report of Soils Tests (Borings 314 through 456), Galveston District Laboratory Report No. 1031, Log of Boring No. 6ST-335; Report of Soil Tests (Boring 74-258 thru 74-276), October 6, 1975.

[21] USACE, Port Arthur and Vicinity, Texas, Hurricane Flood Protection, Supplemental No. 3 to Design Memorandum No. 2, General, Levee Station 62+00 to 228+95, December 1967, p. 19. (Hereafter cited as Design Memorandum No. 2, Supplement No. 3.)

[22] Report of Soils Tests (Borings 314 through 456), Galveston District Laboratory Report No. 1031, Aerial November 10, 1962, Sheet 6 of 6, Log of Boring No. 6ST-335, Test Data Summary Boring HA-335A, and Test Data Summary HA-449A; Report of Soil Tests (Borings 1067 thru 1070) Galveston District Laboratory Report No. 1174, February 13, 1967, Log Boring No. 3ST-1067.

[23] Design Memorandum No. 2, Supplement No. 3, p. a.

[24] Design Memorandum No. 2, Supplement No. 3, pp. 19-20 and 22.

[25] Comments on 1st Indorsement, March 19, 1968, p. 1.

the very soft waste material was displaced, DM No. 2-3 called for a layer of fill to be pushed across the displaced material within the swamp/marsh.[26] The USACE documentation supports that petroleum-related wastes were located in the marsh and bayou area.

As part of the hurricane levee construction, a ditch, or collection channel was added to the interior portion of the hurricane levee (i.e., the BP/Total Refinery side) to assist with conveying waste and water flows from the BP/Total Refinery (see attached Figures 9 and 10). Wastes and storm water runoff from the interior portions of the BP/Total Refinery flowed to the collection channel. Several drainage structures were built to allow flows from the collection channel to pass under the levee and to the swamp/marsh. The first structure of interest is Drainage Structure No. 3 located at Station 84+60. Drainage Structure No. 3 is a 24-inch reinforced concrete pipe. The drainage structure had flap gates on the outlet side of the structure.[27] Storm water runoff from the BP/Total Refinery, an area of about 9 acres, discharged through Drainage Structure No. 3. A high-level bypass weir conveyed industrial waste and storm water runoff through the levee via Drainage Structure No. 3 to the marsh. This weir prevented industrial waste and storm water runoff from entering the collection channel during normal tidal conditions. However, during high tides when the Drainage Structure No. 3 was blocked, the water was to overflow the weir and enter the collection channel.[28] Prior to 1982, during heavy rain events, oily water discharged to the Molasses Bayou Wetlands (swamp/marsh) through a ditch associated with this outfall.[29]

The second structure is Gravity Drainage Structure No. 5 located at Station 122+90. This structure is a 5' x 5' x 195' concrete box with emergency slide gates and flap gates. The flap and side gates are controlled by manually operated lifts equipped with an adapter bracket so the gate can be operated by portable electric power units.[30] Design plans for Drainage Structure No. 5 indicated that once the structure was built, storm water runoff from most of subdivision A-2 (general area serviced by Outfall 001) and all of subdivision B of subarea D-4 (general area serviced by Outfall 002) was to be discharged through Drainage Structure No. 5 to "the main outfall adjacent to the area." As of December 1967 (prior to the construction of the levee), the Atlantic Refining Company was discharging its separator effluent to the outfall (Separator Outfall) at a flow of 2,000 gallons per minute (gpm), but this amount was to increase to 6,000 gpm once the company put into operation facilities that were being designed. To control "runoff and plant waste" to Drainage Structure No. 5, culvert No. 7 on the collection channel was to be kept shut during normal tides. If during high tides Drainage Structure No. 5 became blocked, then culvert No. 7 would be opened to prevent flooding and the flow in the collection channel would flow to the east toward

[26] Design Memorandum No. 2, Supplement No. 3, p. 23.

[27] Design Memorandum No. 2, Supplement No. 3, p. 30 and Exhibit C-6, page 3 of 5.

[28] Design Memorandum No. 2, Supplement No. 3, pp. 5 and 10.

[29] David Buchanan to Gary Schroeder, Interoffice Memorandum, TDWR, March 8, 1982; TDWR, letter to Walter W. Loper, Plant Manager, March 8, 1982.

[30] Design Memorandum No. 2, Supplement No. 3, pp. 15, 30, Exhibit C-6, page 2 of 5; USACE, Port Arthur, Texas, Levee, Sta. 110+00 to Sta. 161+00, May 1972, Drawing Numbers 16 -18.

the Crane Bayou pumping plant.[31] Attached Figures 9 and 11 show the locations of the BP/Total Refinery drainage structures.

The third structure is Culvert No. 4 located at Station No. 108+20. Culvert No. 4 is a 5’ x 4’ x 30’ concrete box located at Station No. 108+20. The culvert was designed to carry the peak inflows from the collection channel during a 50-year rainfall without flooding.[32]

The fourth structure is Culvert No. 7 located at Station 129+90. Drainage Culvert No. 7 consists of two 5’ x 4’ x 62’ standard Texas Highway Department multiple concrete box culverts. The culverts are equipped with slide-gates on the inlet side of the structure. Culvert No. 7’s slide-gates remained shut during normal tides to control “runoff and plant waste” to Drainage Structure No. 5. If Drainage Structure No. 5 becomes blocked during high tides, Culvert No. 7’s slide gates would be opened to prevent flooding by allowing waters in the collection channel to flow to the Crane Bayou pumping plant.[33]

An inlet structure, Structure No. 6, is located at Station 127+55. Structure No. 6 is a single 5’ x 4’ gated inlet structure. The purpose of the structure is to allow water to pass through the hurricane levee to an existing water collection pool used for fire protection and process water storage. Structure No. 6 was equipped with slide gates. An interior levee was to be built along the right bank of the collection channel to confine flows from the main collection channel from discharging into the fire protection pool.[34]

Despite the construction of the hurricane levee proximate to the BP/Total Refinery, provisions were made for waste discharges to continue to flow through the BP/Total Refinery outfalls to both the marsh area and Molasses Bayou through the drainage structures constructed as a part of the hurricane levee project. Attached Figure 9 depicts the complete pathways which allowed the discharge of wastes during the BP/Total Refinery’s post-levee construction operating timeframe.

CDM Smith appears to make contradictory statements in its report regarding the BP/Total Refinery’s discharge to the Right Prong. CDM Smith states that “process water and stormwater outfalls never discharged directly into the Right Prong or the Site.”[35] This statement contradicts a statement made by CDM Smith that after the construction of the hurricane levee, “the Separator Canal, which previously conveyed treated wastewater, was converted to a stormwater only discharge. The former separator canal channel/outfall was replaced with a gated pipe [Gravity Structure No. 5] through the hurricane levee. Outfalls 001 and 002 were diverted through a channel running on the inside of the hurricane levee and

[31] Design Memorandum No. 2, Supplement No. 3, p. 10 and Plate 4.

[32] Design Memorandum No. 2, Supplement No. 3, pp. 15-16.

[33] Design Memorandum No. 2, Supplement No. 3, pp. 4, 10, 16 and 31, Exhibit C-6, page 5 of 5; Port Arthur, Texas, Levee, Sta. 110+00 to Sta. 161+00, May 1972, Drawing Numbers 19-21.

[34] Design Memorandum No. 2, Supplement No. 3, pp. 17-18, 31, and Exhibit C-6, page 4 of 5; USACE, Port Arthur, Texas, Levee, Sta. 110+00 to Sta. 161+00, May 1972, Drawing Number 14 and Drawing Number 15.

[35] CDM Smith Report, July 24, 2018, S-1.

exited through the gated pipe. During this interval, the separator canal was allowed to silt in, and the primary storm water conveyance was _*diverted to the Right Prong*_."[36] [Emphasis added]

Not only did the storm water discharge from the BP/Total Refinery to the Right Prong, but records indicate that storm water discharged from these outfalls exceeded permitted concentrations of oil and grease. For example, a discharge from Outfall 002 in December 1978 had a concentration of 1,072.5 mg/L of oil and grease which exceeded the permitted limit of 15 mg/L.[37] Records further indicate that discharges from Outfall 001 and Outfall 002 between December 1988 and December 1992 frequently contained oil sheens and had oil and grease at levels that exceeded permitted values. Contaminants discharged from the BP/Total Refinery via these outfalls included hydraulic oil, fuel oil, diesel and crude oil.[38] In 1994, Fina entered a Consent Decree that required the company to, among other things, implement spill control and containment measures.[39]

Fina's 1992 Work Plan for the Separator Canal (revised to 1996) indicated that the metal flume in the canal had deteriorated and leaked "water from the separator canal into Molasses Bayou."[40] On March 11, 1991, an "obnoxious odor and visible iridescent sheen were produced" in the water of Separator Canal when sediments were disturbed during the excavation of a trench to install a pipeline across the canal.[41] Analytical results taken from sediments stockpiled in a containment area had concentrations of lead (2,620 mg/kg), aluminum (14,000 mg/kg), TPH (14,000 mg/kg), and phenanthrene (15,000 ug/kg).[42] The aluminum likely came from aluminum sulfate used at the BP/Total Refinery to remove suspended solids in the BP/Total Refinery's wastewater.[43] Excavations along the channel of the Molasses Bayou west of the separator canal produced sheens when sediments were disturbed.[44] Sampling data indicated that the sediments in the Molasses Bayou Channel furthest west and away from the Separator Canal had the highest concentrations of TPH, while oil and grease concentrations diminished in the sediments furthest west and away from the Separator Canal. Concentrations of TPH and oil & grease were higher in the sediments of Molasses Bayou Channel than in the surrounding marshlands.[45] Attached Figure 12 shows the sample data discussed above.

The March 2000 Resource Conservation and Recovery Act (RCRA) Facility Investigation Phase 1 Separator Canal Investigation Report found the highest concentrations of TPH and lead in Separator

---

[36] CDM Smith Report, July 24, 2018, p. 4-2.

[37] Discharge Monitoring Report, TX0004201, Outfall 002, January 5, 1979.

[38] Letter from Fina to USEPA, May 7, 1992.

[39] NPDES Compliance Inspection Report, May 31, 1996.

[40] Jones & Neuse, Inc., RCRA Facility Investigation Phase 1 Work Plan for the Separator Canal, March 1996, p. 13.

[41] Jones & Neuse, Inc., RCRA Facility Investigation Phase 1 Work Plan for the Separator Canal, March 1996, p. 16.

[42] Jones & Neuse, Inc., RCRA Facility Investigation Phase 1 Work Plan for the Separator Canal, March 1996, p. 19.

[43] Jones & Neuse, Inc., RCRA Facility Investigation Phase 1 Work Plan for the Separator Canal, March 1996, p. 20.

[44] Jones & Neuse, Inc., RCRA Facility Investigation Phase 1 Work Plan for the Separator Canal, March 1996, p. 20.

[45] Jones & Neuse, Inc., RCRA Facility Investigation Phase 1 Work Plan for the Separator Canal, March 1996, pp. 17 and 22.

Canal sediments at sampling location SS-4 just south of the flume. Elevated concentrations of Skinner List volatile and semi-volatile constituents were found at the same locations that had elevated TPH concentrations.[46] This data supports that contaminants discharged from BP/Total Refinery Outfalls 001 and 002 contained contaminants that settled in the Separator Canal prior to being transported to the Neches River.

In conclusion, based on the SLCCP's analysis, the Molasses Bayou undoubtedly served as a complete pathway for discharges from the BP/Total Refinery's three outfalls and waste oil pits to migrate to, and impact the Site throughout the BP/Total Refinery's operating timeframe.

3. Hydrology and Sediment Transport Capacity Analysis

This rebuttal addresses statements made in Section 3 of the CDM Smith Report. As discussed in more detail below, there is substantial evidence that Molasses Bayou and the surrounding wetlands area are highly influenced by tidal action and flow both to and from the BP/Total Refinery allowing wastes to be transported to the Site. Additionally, there is no evidence of diminishing sediment transport from the BP/Total Refinery to the Site.

3.1 Present Day Hydrology

BP/Total assert in the CDM Smith Report: "The wetlands proximate to the refinery drain into the Right Prong. As described in Section 3 herein, measurements of present-day surface water flow show that the Right Prong drains to the Boat Canal, and not towards the Molasses Bayou Waterway and Star Lake Canal Superfund Site. The Right Prong has not drained solely to the Molasses Bayou Waterway since pre-industrial times, prior to the installation of the Boat Canal in the 1930's."

Three lines of evidence refute CDM Smith's suggestion that discharges to the Right Prong can only drain unidirectional into the Boat Canal. These lines of evidence include:

- Data provided in the CDM Smith Report, which shows bi-directional flow at three flow meters, as well as tidal fluctuations in water elevation;
- Data from a tide gauge on the Rainbow Bridge (located less than a mile from the site) where bi-directional flow has been observed for years; and
- Analysis of the orientation of oil control booms in the Boat Canal shows a bi-directional flow of water in historical aerial photographs.

Additionally, the assertion that dispersion of contaminants from the BP/Total Refinery to the Site is dependent on the Right Prong draining solely to the Molasses Bayou Waterway does not reflect the hydrology of wetland systems, as shown by the flow/water level data and the computational hydraulic model discussed herein that was used to evaluate dispersion of contaminants.

---

[46] Separator Canal Investigation Report, March 2000, pp. 2, 9, and Table 4.

These well-documented, bi-directional tidal currents provide the driving forces for transport of water and associated constituents throughout the continuous waterway. In addition, computations based on the tidal forces indicate that a particle of water would easily be transported from the eastern end of the Right Prong to the Western end of the Left Prong by these currents. This conclusion is supported by the data presented in the following sections.

3.1.1 Flow and stage data presented in the CDM Smith Report

As documented in the CDM Smith Report, flow in the Boat Canal and Right Prong is tidally influenced and bi-directional. Flow towards the Boat Canal occurs primarily during the ebb tide, and flow towards the Molasses Bayou Wetland occurs primarily during flood tide (Figure 3-3 of the CDM Smith Report). Figure 3-2 of the CDM Smith Report shows that at Station 1, located near the head of the Boat Canal, flow is predominantly away from the Boat Canal (and towards the Molasses Bayou Wetland). These data are supported by the net current strengths at Stations 2 & 3, where flow away from Boat Canal (and towards the wetlands) is substantial.

Not surprisingly, these data indicate water level/flow in Molasses Bayou Wetland is tidally influenced. In addition to gravitationally induced tidal changes in water level, other climactic factors can affect flow and water level. Winds from the south can force water deep into the marshes, mimicking a strong high tide (conversely, winds from the north can force water out of the marshes and into the Gulf, mimicking a strong low tide). Although the data are limited to a single month, fluctuations in water level as large as two feet are present and are likely due to wind-driven water movement, which is a regular occurrence in Gulf coast tidal marshes. Tropical storm events can also lead to significant flooding when water is forced up the Neches River and into tidal marshes.

The CDM Smith data set is limited to a single month in the winter when winds are generally from the north and create low water level elevations in Gulf coast marshes. As such, tropical events and southerly wind events are not captured creating a bias in the data. Because of this bias, the flow of water into Boat Canal and towards the Molasses Bayou Wetland, which is already substantial, is significantly underestimated by CDM Smith.

3.1.2 Rainbow Bridge

Water level transducers mounted under the Rainbow Bridge, 0.66 miles downstream of the mouth of Boat Canal, measure and record the actual water stage[47], as well as velocity and azimuth of flow[48] every 6 minutes. At the Rainbow Bridge, the current velocity is generally about 1 knot (1 knot equals about 1.7 feet per second). During high flow riverine discharge the velocity may exceed 5 knots. Two azimuths account for most of the flow directions:

---

[47] National Oceanic and Atmospheric Administration (NOAA). Tides and Currents. 8770520 Rainbow Bridge Texas Observed Water Levels. https://tidesandcurrents.noaa.gov/waterlevels.html?id=8770520&units=standard&bdate=20100311&edate=20100311&timezone=LST/LDT&datum=MLLW&interval=6&action=

48 NOAA. Tides and Currents. Rainbow Bridge (sn0501).Tidal Strength and Direction. https://tidesandcurrents.noaa.gov/cdata/DataPlot?id=sn0501&bin=0&bdate=20100311&edate=20100311&unit=1&timeZone=LST/LDT

- An azimuth of about 290 degrees during “flood” tide when the rising tide advances landward. The azimuth of about 290 degrees means the tide is advancing upstream with a direction of flow from east to west, which corresponds to the axis of the river channel under the bridge;
- An azimuth of about 110 degrees occurs during “ebb” tide, which is when the tide recedes from land. The 110 degree direction means the water is flowing approximately from west to east, and the 110 degree azimuth is approximately the axis of the river channel when looking downstream.

As the tide is changing from flood to ebb or vice versa, the velocity will approach zero and the direction will be indeterminate for a short period. Attached Figure 13 shows observed water levels and observed currents at the Rainbow Bridge gauge from April 27 through 28, 2018. This figure shows the relationship between tide level and tidal velocity and azimuth. It can be concluded from this data that the normal tide pattern is bi-directional.

Thus, these data in combination with the flow and water level data presented in the CDM Smith Report clearly indicate that flow in the Molasses Bayou Wetland is tidally influenced and bidirectional, and has been during the duration evaluated in these reports. Accordingly, it is established that water flows from the Site to the Molasses Bayou Wetland via the Right Prong.

3.1.3 Oil control boom analysis

In addition to the Rainbow Bridge water level and flow data, an analysis of the orientation of oil control booms in historical aerial photographs of the Boat Canal shows a bi-directional flow of water. Using date-stamped, historical aerial photographs of the Site (available on Google Earth), the approximate time of day the photograph was taken can be determined using the orientation of the shadow of a tall slender object, such as a flare stack[49]. Review of the tidal records for that day allows inference of the tide stage in the photograph.

[49] Data on the position of the sun during the day for a given geographical location are available from the US Naval Observatory website. U.S. Naval Observatory (USNO). Sun or Moon Altitude/Azimuth Table. http://aa.usno.navy.mil/data/docs/AltAz.php#Notes

Table 1. Analysis of Boom Orientation and Tidal Direction

Parameter	Date of Aerial Photograph				
	04/09/05	09/25/05	03/26/15	01/29/17	09/01/17
Sun Azimuth (degrees)	137	175	137	159	146
Time (Local)	1200	1257	1148	1122	1219
Stage Calculated NAVD from MLLW (feet)	0.14	2.88	0.77	0.35	3.15
Stage Predicted MLLW (feet)	0.911	0.939	0.604	0.286	0.988
Stage Preliminary MLLW (feet)	0.49	NP	1.12	0.73	3.5 EST
Stage Verified MLLW (feet)	NV	3.23	NV	0.7	NP
Tide Ebb or Flood Based on Tidal Elevation	Ebb but almost flat	Ebb but almost flat	Flood	Ebb	Ebb
Tide Ebb or Flood Based on Boom	Ebb	Ebb	Flood	Ebb	Ebb

Notes:
NA - No tidal information available for this date
MLLW - Mean Lower Low Water
NV - No verified data for this date
NP - No preliminary data for this date
EST - Estimated last verified data was ≈3.5 MLLW at ≈1800 hours on August 31, 2015

The table above present's data for five dates on which aerial photographs are available, the time of day and date of the photograph can be determined, and tidal data are available. This allows correlation of the tidal stage to the water level in the photograph.

Aerial photographs that show the orientation of oil control booms were viewed for a variety of dates to document bi-directional flow. An oil control boom is a flexible floating barrier attached to a cable and anchored to both banks of a water body. Booms maintain enough slack so that in a current they assume an approximately circular or parabolic shape when viewed from above. This bowed shape also allows one to examine aerial photographs and quickly infer from the boom shape the direction of flow in the water body.

Attached Figures 14 and 15 show aerial photographs of the Boat Canal out to the Neches River on March 26, 2015, and January 29, 2017, respectively. Oil control booms are observed across the Boat Canal itself and across the entrance of Right Prong into the Boat Canal. In some photographs, booms are also observed across an inlet entering the marsh on the west bank of the Boat Canal between the Right Prong and the Neches River (see attached Figure 15, label D for location of boom). Based on the boom curvature observed in each photo, the tide is in a state of flood for the March 2015 aerial image (attached Figure 14) and in a state of ebb for the January 2017 aerial image (attached Figure 15). This is confirmed by examination of the tidal record on that date as seen in Table 1 above. For the five occasions where the boom orientation and the tide position were compared, there was agreement between the tidal current direction (ebb or flood) and the orientation of the booms.

As with the tide gauge data, analysis of the oil boom orientation shows that the Molasses Bayou Wetlands is a tidally influenced wetland with bidirectional flow. Accordingly, it is again established that water flows from the Site to the Molasses Bayou Wetland via the Right Prong.

3.2 Review of Aerial Photographs and Historical Maps

The examination of aerial photographs during this time period also provides insight into the Site hydrology and shows the open channels and flow directions. The CDM Smith Report examined aerial imagery from several years and for each year provided diagrams depicting the inferred predominant flow direction in major channels. While aerial imagery is useful in discerning where channels exist and potential connectivity, inferring the *predominant* flow direction in a tidal marsh from aerial imagery is highly speculative at best. In addition, as this is tidal marsh, using single-headed arrows on these diagrams is misleading; flow is bi-directional as documented above, and double-headed arrows showing bi-directional flow are appropriate.

The analysis below is based on and references the aerial imagery provided in the CDM Smith Report. Where imagery was not supplied in the CDM Smith Report, supplemental aerial images are included as part of this report[50].

3.2.1 1938 Aerial Photograph

BP/Total assert in the CDM Smith Report: "The installation of the Boat Canal in this timeframe started the hydrologic transition from pre-industrial times to how the system is today, with the Right Prong draining through the Boat Canal, away from Star Lake Canal Superfund Site."

This statement is not supported by the aerial photography and is not correct for the following reasons. In the 1938 aerial imagery included in the CDM Smith Report, the flow pathways are observed to be continuous between the Left Prong, to the Right Prong, and Boat Canal. In the center of the system is the confluence of the Left Prong, Right Prong, and Molasses Bayou. As discussed previously, this confluence provided a connection between the east-west pathway and a north-south pathway, which extended to the Neches River. The Boat Canal does provide an alternative flow path to the Neches River for the Right Prong. Flow was tidal and bi-directional, and to this day flow remains bi-directional as documented herein.

3.2.2 1953 Aerial Photograph

BP/Total assert in the CDM Smith Report: "In the Right Prong, depositional sediment bars are visible that could only have been formed if the predominant flow in the Right Prong was towards the Boat Canal, and not towards Molasses Bayou. A narrowing of the Right Prong channel near the historical confluence with the Left Prong is also visible, indicative of this reach being at the end of a channel, and not at the mouth"

CDM Smith appears to interpret light shading in the 1953 aerial photograph as depositional bars. However, this shading could be the result of other factors, including the effect of sun and shadow and the

---

[50] Google Earth Pro. Historical Imagery. Various dates 1937-present.

different vegetation along the Right Prong due to slight differences in land elevation. During a March 2018 boat ride from the western end of the Left Prong to the eastern end of the Right Prong, *Phragmites* adjacent to the channel were noted to be 10 feet or more tall. Depositional bars were not observed during the boat ride. Depending on the time of day, the time of year, and the resulting angle of the sun and shadow, objects could be misinterpreted on aerial photography without the necessary field verification.

Additionally, interpreting channel widths from aerial photography without adequate control of tidal and survey data is inappropriate. As such, CDM Smith's assertion that the Right Prong narrows is unfounded.

3.2.3 1966 Aerial Photograph

BP/Total assert in the CDM Smith Report: 1) "The 1966 aerial photograph shows the beginning of an open water area forming between the Molasses Bayou and the Right Prong. Open water forms in wetland systems when the inputs of new sediments and nutrients to the area are not sufficient to replenish the natural subsidence of the mud line due to settling. The presence of open water adjacent to the Right Prong is indicative of a diminished sediment and nutrient load from the Right Prong." 2) "Depositional sediment bars are also visible in the Main Stem and Left Prong of the Molasses Bayou. The bars show predominant flow is to the northeast (from Star Lake Canal to the historical confluence)."

The formation of an open water area is clear on the 1966 aerial photograph, but changes will be difficult to interpret unless the season of the year, the water elevation in the open water, and the time of day are known for the photograph. CDM Smith hypothesizes that the open water area is due to diminished sediment and nutrient load from the Right Prong. This hypothesis does not account for relevant published scientific data which have documented that open water areas (or marsh collapse) occur because of increased nutrient load[51] and increased inundation[52]. In fact, marsh collapse in this area is indicative of greater water flow (and associated nutrients) from the Right Prong to the Left Prong, which is likely the result of increased tidal flow from the Boat Canal into the Molasses Bayou Wetland. This effect was likely compounded by increased erosion of pond boundaries as it enlarges and increased fetch lengths which allow greater erosion of the perimeter. Accordingly, any depiction of open water adjacent to the Right Prong of Molasses Bayou is not necessarily indicative of a diminished sediment and nutrient load from the Right Prong.

3.2.4 1970 and 1979 Aerial Photographs

BP/Total assert in the CDM Smith Report: "The 1970 photograph shows the continuing presence of the open water area. Silting in of the historical confluence of the Right Prong with the Left Prong is also visible, which would be caused by a lack of sufficient energy (in the form of surface water flow) to maintain

[51] Deegan, L.A. et al. 2012. Coastal eutrophication as a driver of salt marsh loss. Nature 490:388-392.

[52] Couvillion, B.R. et al. 2013. Forecasting the effects of coastal protection and restoration projects on wetland morphology in coastal Louisiana under multiple environmental uncertainty scenarios. J. Coastal. Res. 67:29-50. Couvillon, B.R. and, Beck H. 2013. Marsh collapse thresholds for coastal Louisiana estimated using topography and vegetation index data. J. Coastal. Res. 63:58-67.

the channel open. These processes are continued evidence that the Right Prong primarily drains to the Boat Canal, and not towards the Left Prong and Star Lake Canal Superfund Site."

The silting of the Right Prong at its confluence with the Left Prong appears to be due to a diversion of the Right Prong into the newly formed open water area. The result is a continuous pathway of the Right Prong to the main stem of the Molasses Bayou Waterway through the open water area. The upstream portion of the Right Prong is bypassed by the open water area (this is common in high-energy waterways, cf. oxbow lakes). In summary, by 1970 the continuous pathway includes the newly formed open water area. The change in path appears at least partially due to man-made activities to achieve drainage or access to areas for recreational activities. In the 1979 aerial photograph, the Right Prong continues to feed the open water area. There appears to be no evidence to support the assertion that the Right Prong primarily drains to Boat Canal, as the collapsed wetlands are indicative of increased flow and inundation.

3.2.5 1989 Aerial Photograph

BP/Total assert in the CDM Smith Report: "No channels directly connecting the Left Prong and Right Prong are visible in 1989. The open water area—indicative of a diminished sediment transport capacity in the Right Prong to the interior of the Molasses Bayou wetlands—continues to grow larger in 1989. The growth in the open water area indicates that sediment transport in the Right Prong to the interior of the wetland continues to diminish. The Right Prong between the open water area and the historical confluence of the Left Prong is barely distinguishable, indicative of a lack of energy (in the form of surface water flow) to maintain the channel open."

While it is true that the open water area appears to grow larger in 1989, this is expected with continued increased flow into this area causing increased nutrient load and inundation (see Section 3.2.3). Water from the north and the Right Prong meets near the southeast part of the open water area. There is nothing to suggest that these changes are due to a decline in the energy of the water; in contrast, these changes are likely due to increased water flow as discussed above in Section 3.2.3. Additionally, the 1989 aerial imagery is not of sufficient quality to conclude that no channels directly connect the Left Prong and the Right Prong.

3.2.6 2006 Aerial Photograph

BP/Total assert in the CDM Smith Report: "Except for a thin and minor channel at the north end of the large open water area, no hydraulic connection between the Right Prong and the Left Prong is visible. Other channels and water bodies connected to the Right Prong, including the north-south ditches visible and two open water areas south of the Right Prong, are visible. These additional channels and water bodies enhance the amount of storage in the Right Prong system, precluding the need for water to breach the end of the Right Prong and spill into the Left Prong."

In the copy of the CDM Smith Report received, no photograph is included on the title page for Figure 3-5f. The following discussion is based on our review of the Google Earth October 31, 2006 aerial photograph of the area (attached Figure 16). As noted in the CDM Smith Report, a channel connecting the open water area and the Left Prong is clear in the 2006 imagery. Although this is the first time in the CDM Smith

Report this channel has been noted, publicly available Google Earth imagery dated January 11, 1996, clearly shows this channel (attached Figure 17; the channel appears to be present in the 1989 Google Earth imagery, but the quality of the image is poor).

The gathering of streams at the southwest corner of the open water area also still exists. The south side of the open water area is hydraulically connected with the meanders of the Right Prong at several locations and with the ditch on the west side of the semi-rectangular pond. Flow from both have connectivity to go south in Molasses Bayou to reach the Left Prong and flow all the way to Star Lake Canal. Molasses Bayou appears silted in about 0.6 miles north of where the 12 o'clock outfall from the pond is located.

3.2.7 2017 Aerial Photograph

BP/Total assert in the Report: "The 2017 aerial photograph shows that the Right Prong has silted in at the historical confluence with the Left Prong, and the open water area has continued to grow in size. Meanwhile, the Left Prong is continually open as a surface water channel. Only two small channels are visible potentially connecting the Right Prong and the Left Prong."

As noted in the CDM Smith Report (and above in Section 3.2.4), connectivity between the open water area and the Left Prong has been previously established. Given the previous development of an alternative route between the open water area and the Left Prong, the silting in of the Right Prong at its historical confluence with the Left Prong does not indicate a lack of connectivity between the two, and, as such, is inconsequential (and expected).

In addition to the distribution of constituents which occurs at normal tidal stages, overland distribution of constituents can occur at high stages. Attached Figure 18 is an aerial photograph of the Site during Hurricane Harvey taken on September 1, 2017. This shows the area completely inundated. Based on the tide gauge at Rainbow Bridge, the stage is estimated to have been at about 3 feet MLLW for over 2.5 days before the tide gauge quit recording data. The magnitude of inundation was such that the roadway to the flare located near the south end of Boat Canal at UTM (meters) 414,399 E, 3,315,717 N, was underwater.

3.3 Computational Transport Modeling

The CDM Smith Report hypothesizes that the silting in of the Right Prong at its historical confluence with the Left Prong indicates a greatly diminished ability to transport constituents from the Right Prong to the Left Prong. However, there is no evidence of diminishing sediment transport capacity in the Molasses Bayou marsh system. Although the western part of the Right Prong is silted-in, the previous discussions on the continuity of the Molasses Bayou system have demonstrated that the development of the open water area enabled a continuous pathway for water or constituents to be transported from east to west.

Computational transport modeling, conducted based on bi-directional tidal data, shows that a volume exiting from a pipe into the Boat Canal or which had historically discharged into the marsh near the confluence of the Right Prong and the Boat Canal, would be dispersed due to bi-directional flow. Attached Figure 19 is a snapshot view of the expected dispersion approximately 146 days after a discharge of

3 MGD into the Boat Canal. As can be seen, the Right Prong, the open water area, and the Left Prong show a high level of contaminant transport[53].

During a rising tide in the Neches River, water and any constituents in the water would be pushed from the Boat Canal or the eastern parts of the Right Prong westward along the Right Prong. As the tidal cycle continued, transport into the marsh would continue until the tide began to fall. Once the tide began to fall, water would drain from the watershed via the Left Prong and Right Prong and the Boat Canal back toward the Neches River. During each cyclic transport of water into the Left Prong and Right Prong and the marsh, constituents would have an opportunity to sorb to vegetation or sediment and would be obstructed from flushing out with the falling tide. Diffusion and dispersion could further spread the constituents with each bi-directional cycle of the tide.

4. Chemistry Analysis

BP/Total assert in the CDM Smith Report that a simple comparison of chemical concentrations between sediments at two distant BP/Total Refinery outfall locations versus sediments at the Site provide evidence for lack of nexus between the BP/Total Refinery and the Site. In essence, CDM Smith proposes a simple binary option for potential BP/Total Refinery nexus—either the BP/Total Refinery is the (only) source of contamination or it is not. CDM Smith concludes that the BP/Total Refinery is not the (singular) source to the Site, based on their conclusion that the concentrations of chemicals of concern are lower in the limited sediment data they evaluated near two BP/Total Refinery outfalls compared to sediments at the historic intersection of the Right Prong with the Left Prong.

CDM Smith’s analysis is clearly flawed. CDM Smith did not investigate other likely BP/Total Refinery sources of contamination to the Right Prong. Thus, their ability to argue chemicals of concern were not transported to the Site from the BP/Total Refinery via the Right Prong is not defensible. In addition, CDM Smith did not consider Site sediment chemical composition data that, in the SLCCP’s opinion, demonstrate likely contribution of chemicals of concern to Molasses Bayou from the BP/Total Refinery. Flaws in CDM Smith’s sediment chemistry evaluation and the SLCCP’s analysis for nexus between the BP/Total Refinery and the Site are presented below.

4.1 BaP is a Poor Marker for BP/Total Refinery PAH Contributions to the Site

Benzo(a)Pyrene (BaP) is an inappropriate choice for CDM Smith to use as a marker chemical for potential petroleum PAH contribution from the BP/Total Refinery to the Site. BaP is not a petroleum-derived PAH and is not a suitable marker for potential contribution of petroleum PAH from the BP/Total Refinery to the Site. Furthermore, BaP is not a primary or secondary ecological risk driver at the Site. Generally, BaP is recognized as a ubiquitous anthropogenic contaminant. The SLCCP recognizes that, in part, BaP found in Site sediments likely arises from combustion-derived sources such as atmospheric fallout and general land runoff. While the BP/Total Refinery likely generated combustion-derived PAH such as BaP (see

[53] An animation showing discharge over a years’ time is also available for viewing.

Table 2) it is reasonable to assume that the BP/Total Refinery is a much stronger source of petroleum-derived PAH such as phenanthrene and acenaphthene—compounds that are the primary and secondary risk drivers in sediments at MB-56 (the historic confluence of the Right Prong and Left Prong).

Benzo(a)pyrene is, at best, found in de minimis concentrations in petroleum. Using this chemical as a proxy or tracer for petroleum-derived contamination in Molasses Bayou sediments is inappropriate. Instead, one of the many 2- or 3-ring PAH that are abundant in petroleum should be used as a tracer for potential BP/Total Refinery-derived PAH.

PAH compounds are ubiquitous in the environment and originate from a large number of sources.[54] PAH sources can be broadly classified as biogenic, petroleum-derived (or petrogenic), or combustion-derived (pyrogenic). Petroleum and pyrogenic materials contain hundreds of PAH parent and alkylated isomers at different abundances and distributions of PAH. These chemical patterns can be used for PAH source identification.[55]

The PAH composition of petroleum is dominated by lighter molecular weight, 2- and 3-ring PAH. Combustion-derived pyrogenic PAH are generally composed of dominantly high molecular weight 4- through 6-ring parent PAH, which includes BaP.[56][57]

Benzo(a)pyrene is classified as a pyrogenic PAH, not a petroleum-derived PAH. Benzo(a)pyrene is either not present (e.g. diesel fuel) or found only at de minimis concentrations in other petroleum (e.g. crude oil). To illustrate, representative PAH compositional histograms of petrogenic crude oil (Alaska North Slope) and diesel fuel are contrasted with that of pyrogenic-derived coal tar (attached Figure 20). Consistent with the description above, it can be seen that crude petroleum and diesel fuel are enriched in lighter molecular weight PAH and contain only very small amounts of higher molecular weight 4- to 6-ring PAH. Notably, BaP (a 5-ring PAH) is present at only trace concentrations in the Alaska North Slope crude oil. However, BaP and other 4- to 6-ring PAH are abundant in the combustion-derived coal tar—typically hundreds of times higher in relative concentration than found in petroleum.

Thus, since benzo(a)pyrene is, at best, a de minimis component of petroleum, it is technically inappropriate for BP/Total to use BaP as a proxy or tracer for petroleum-related contamination in sediments near outfalls from the BP/Total Refinery. The many 2- or 3-ring PAH that are abundant in petroleum are appropriate tracers for BP/Total Refinery-derived PAH. Furthermore, as noted above, remediation at the Site is driven by ecological risk, and BaP is not a primary or secondary ecological risk driver in the Thiessen polygons identified for remediation.

---

[54] ATSDR (1995). Toxicological Profile for Polycyclic Aromatic Hydrocarbons. US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, Atlanta GA.

[55] Douglas, G.S., Emsbo-Mattingly, S.D., Stout, S.A., Uhler, A.D., and McCarthy, K.J. (2007). Chemical Fingerprinting Methods. *Introduction to Environmental Forensics*, *2nd Edition*.

[56] Douglas, G.S., Emsbo-Mattingly, S.D., Stout, S.A., Uhler, A.D., and McCarthy, K.J. Hydrocarbon Fingerprinting Methods. *Introduction to Environmental Forensics*, *3rd Edition*.

[57] Potter, T.L., and Simmons, K.E. (1998). Composition of Petroleum Mixtures. Total Petroleum Hydrocarbon Criteria Working Group Series. Volume 2. Amherst Scientific Publishers, Amherst MA.

In addition, as CDM Smith points out, the Record of Decision (ROD) calls for monitored natural recovery (MNR) for the two Thiessen polygons closest to the BP/Total Refinery, including the polygon that captures one of the historical confluence point of the Right and Left Prong of Molasses Bayou (MB-56). However, it must be noted that while MNR is the selected remedial action for MB-56, this polygon was ranked as a risk category 4, the highest category ranking for ecological risk.[58] As stated in the ROD, the areas of Molasses Bayou waterway and wetland that were assigned MNR were either characterized by less than a high priority ecological risk ranking (i.e., less than risk Level 4) or (as in the case of the MB-56 polygon) areas that were not suitable for access for construction purposes. In the latter case, the concern for wetlands damage by heavy equipment access and the preparation of staging and dewatering areas led to the selection of the less intrusive MNR remedy. Finally, it is important to note that the primary risk driver for MB-56 is phenanthrene, a PAH abundant in petroleum and petroleum-derived products as discussed in further detail below. The BP/Total Refinery is a logical contributing source of phenanthrene.

4.2 CDM Smith Did Not Consider Other Potential Sources of Contamination to the Site

CDM Smith did not consider other BP/Total Refinery source areas in their evaluation such as SWMU 2 (North Flare Landfill) discharges. Rather, CDM Smith relies on a limited and incomplete set of sediment data from two locations distal to the Site (SWMU 8 and SWMU 11). BP/Total has conducted no monitoring of sediment conditions along the entirety of the Right Prong between the BP/Total Refinery and Molasses Bayou, and thus cannot refute the clear nexus of BP/Total Refinery discharges to the Site. The CDM Smith Report presented historical Total PAH data for a limited number of sediment samples taken immediately proximal to the North Ditch outfall (SWMU 8) to support BP/Total's claim that no PAH from the BP/Total Refinery migrated into the Right Prong (Exhibit 5-1). CDM Smith compared PAH concentrations in SWMU 8 to PAH concentrations in Molasses Bayou to argue against the BP/Total Refinery as a source of PAH to the Site. This argument ignores other potential significant BP/Total Refinery sources that could discharge PAH to the Right Prong and likely migrated to the main stem of Molasses Bayou (i.e., the Site).

One obvious example of a significant BP/Total Refinery PAH source is the former waste disposal area, referred to as the North Flare Landfill (SWMU 2) which is located immediately proximal to the Right Prong. The BP/Total Refinery used this landfill to dispose of petroleum PAH-bearing wastes such as sludges and tank bottoms.[59] The North Flare Landfill operated from the 1950's to 1971. Aerials indicate that this landfill was hydrologically connected to Molasses Bayou (attached Figure 21).

The North Flare Landfill closed in 1971 prior to the construction of the USACE levee. In 1983, the North Refinery Flare and associated pipe racks were constructed directly on top of this former landfill.[60] A portion of waste residues in the top 2' of soil at the landfill were removed as a result of these construction

[58] USEPA Region 6 Star Lake Canal Superfund Site Record of Decision September 2013. Figure 4.

[59] ENSR Prepared for Atofina Petrochemicals, Inc. December 2002. Risk Reduction Rule Standard 3 Closure Corrective Measures Implementation Plan SWMU 2- North Flare Landfill. Document Number 05370-030-510.

[60] ENSR Prepared for Atofina Petrochemicals, Inc. December 2002. Risk Reduction Rule Standard 3 Closure Corrective Measures Implementation Plan SWMU 2- North Flare Landfill. Document Number 05370-030-510.

activities and backfilled with clay fill. However, significant residual wastes below the 2’ excavation were left in place. An Atofina report to TCEQ in 2002 reported the analyses of PAH for the waste residuals that were left in place at the landfill.

Table 2 lists the Total PAH and benzo(a)pyrene (BaP) concentrations reported for two waste residue samples collected in 2002 from the landfill. Table 2 also presents a comparison of the PAH concentrations measured in the landfill waste with those measured in the Site RI sediment sample MB-56. MB-56 is located at the historical intersection (pre-1970) of the Right Prong and the Molasses Bayou Waterway. This comparison shows that PAH concentrations present in North Flare Landfill waste residue are comparable to PAH concentrations detected in Molasses Bayou. Thus, PAH-enriched wastes such as found in the North Flare Landfill are reasonable candidate sources of PAH to Molasses Bayou.

Table 2. A Comparison of Total PAH and BaP Concentrations in SWMU 2 Waste Residues to Sediments at MB-56.

Sample Location	Sample ID	BaP (mg/kg)	Total PAH[a] (mg/kg)
SWMU 2 “waste residue”	U2-B11 W (2-5’)	1.2	147
SWMU 2 “waste residue”	U2-B20 (0.5-3’)	3.1	84
Molasses Bayou/ Right Prong Historic Intersection	MB-56	6.8	191

[a]BP/Total reports only 14 of the 17 PAH measured in Site RI. Accordingly, we have summed the same PAH used by BP/Total in the “Total PAH” listed in this table.

CDM Smith’s analysis of PAH and other contaminants (i.e. metals, PCB, CS_2, and ethylbenzene) is based on data from SWMU 11 (Boat Canal) and a limited subset of data from SWMU 8 (the Separator Canal). The Risk Reduction Rule Standard 3 Closure, Corrective Measures Implementation Plan, SWMU 8 (ENSR, 2005) referenced in the CDM Smith Report includes data that were not considered in CDM Smith’s evaluation.[61] For example, the lead concentration in sediment/soil sample U8-B2 (5’) is 5,060 mg/kg which is significantly greater than the maximum concentration for lead listed in Table 5-1 of the CDM Smith Report for Refinery RCRA investigations (304 mg/kg). Since the Separator Canal was hydrologically connected to the Right Prong of Molasses Bayou before construction of the flume (as described in FTI’s Nexus Summary) all data from SWMU 8 should have been considered in CDM Smith’s analysis. Additionally, other potential source areas at the BP/Total Refinery that had historic hydrological connectivity to the Site, such as SWMU 2, establish a nexus to the Site.

4.3 CDM Smith Did Not Recognize Indicators of BP/Total Refinery PAH inputs to the Site

CDM Smith did not recognize spatial differences in PAH chemistry in the RI data that indicate compositional differences between PAH in Jefferson Canal and Former Star Lake sediments from those in Molasses Bayou.

[61] ENSR Prepared for Total Petrochemicals. March 2005. Risk Reduction Rule Standard 3 Closure, Corrective Measures Implementation Plan SWMU8- Separator Canal. Document Number 05370-030-560.

The Site includes two industrial effluent canals that join just upstream of Former Star Lake. Combined industrial effluents flow downstream through Star Lake Canal before discharging into the Neches River. Molasses Bayou is hydrologically connected to Star Lake Canal just below Former Star Lake, and it too ultimately discharges into the Neches River. The RI has documented elevated levels of PAH in parts of Jefferson Canal, Former Star Lake, and Molasses Bayou AOIs. BP/Total claim that PAH found in Molasses Bayou are simply the result of downstream migration as opposed to contributions from BP/Total Refinery discharges.

CDM Smith did not consider PAH spatial concentration patterns that suggest multiple point sources contribute to PAH contamination across the Site. Furthermore, PAH found in sediments of Jefferson Canal AOI and Former Star Lake AOI have a distinct chemical composition from PAH found in Molasses Bayou. Lastly, elevated TPH and BTEX in Molasses Bayou sediments suggest proximity to an on-going source of hydrocarbons to Molasses Bayou.

CDM Smith claims that the RI data shows a systematic decrease in PAH concentration from Jefferson Canal and Former Star Lake AOIs to Molasses Bayou. However, when all sediment data are plotted (regardless of depth), a more complex spatial pattern emerges. Attached Figure 22 shows average Total PAH concentrations for samples bounded within distinct geographic areas of the Site. Molasses Bayou, the upstream portion of Jefferson Canal AOI, and the lower half (east side) of Former Star Lake AOI contain the highest average Total PAH concentrations. However, the portion of Star Lake Canal that hydrologically connects Jefferson Canal to Former Star Lake and ultimately Molasses Bayou is characterized by very low Total PAH values (average Total PAH = 8 mg/kg). This indicates that PAH contamination appears largely constrained to distinct geographic areas and that limited PAH transport has occurred from upstream down the Star Lake Canal. By extension, this means that localized sources are most likely responsible for PAH found in each area of elevated PAH—including Molasses Bayou. Additionally, elevated Total PAH concentrations in Molasses Bayou are proximal where the Right Prong intersected Molasses Bayou before 1970 and to where the Right Prong currently intersects Molasses Bayou (denoted in attached Figure 23). We contend that this data shows that the BP/Total Refinery is a likely source of PAH to Molasses Bayou.

PAH spatial concentration patterns suggest that multiple point sources contribute to PAH contamination across the Site. This concept is further supported by diagnostic PAH chemistry. Three PAH source diagnostic parameters were evaluated to assess compositional features among PAH at the Site. These analyses, described below, demonstrate that PAH in Jefferson Canal and Former Star Lake have different chemical composition from PAH detected in the Molasses Bayou.

1. *Benzo(a)pyrene versus Phenanthrene Ratios*. As described above, BaP is abundant in pyrogenic materials such as coal tars and other combustion wastes. Petroleum and petroleum-derived products are enriched in lighter molecular weight PAH such as phenanthrene. A cross-plot of BaP versus phenanthrene was examined to identify samples that contain PAH of greater petrogenic character (i.e. enriched in phenanthrene relative to BaP) versus those that are more pyrogenic in character (i.e. enriched in BaP relative to phenanthrene). Samples with Total PAH concentrations greater than 100 parts per million (ppm) were used in this analysis in order to optimize identification of uniquely

sourced samples. The results of this analysis reveal that pyrogenic-enriched sediments are located within Jefferson Canal AOI and Former Star Lake AOI (i.e. upstream sources) (attached Figure 24). Conversely, phenanthrene-enriched (petroleum-sourced) PAH bearing sediments are primarily located in Molasses Bayou. This analysis shows that the Molasses Bayou has a distinct, petroleum-enriched source. That source is most likely the BP/Total Refinery.

2. *PAH Compositional Differences by Molecular Weight*. PAH are composed of two or more fused aromatic rings. Petrogenic PAH are compositionally dominated by 2- to 3-ring PAH (low molecular weight PAH), whereas pyrogenic PAH contain a proportional abundance of 4- to 6-ring PAH (high molecular weight PAH). A cross-plot of % 2 and 3-ring PAH versus % 4, 5, and 6-ring PAH was examined to explore basic chemical compositional feature among PAH found in sediments at the Site using these basic compositional metrics (attached Figures 25-27). The plot contains several data populations. One end member population is represented by samples with percent 2-, 3-ring PAH values >85%, which is characteristic of very light petroleum materials such as distillate fuels. Four samples fall in this category and are found in three locations- one upstream sample in Jefferson Canal AOI, samples at depth in Jefferson Canal Spoil Pile AOI, and one sample in Molasses Bayou waterway (attached Figure 25). The other end member population in this chart is characterized by samples containing high proportions % 4- to 6-ring PAH (>60%), which is characteristic of pyrogenic materials such as weathered coal tars and combustion wastes. Samples in this category are located in Jefferson Canal Spoil Pile AOI, the lower half of Star Lake, and near the confluence of Star Lake Canal and Molasses Bayou waterway (attached Figure 26). Samples in the intermediate range of this chart are typical of heavier petroleum, petroleum residuals, and petroleum mixed with combustion PAH. Samples in this category are found largely in Molasses Bayou waterway (attached Figure 27). It is evident that the chemistry of samples in Molasses Bayou are on balance, significantly different in basic PAH composition from upstream PAH found in Jefferson Canal and Former Star Lake, indicating a petroleum-enriched source of PAH to Molasses Bayou.

3. *Acenaphthylene Enrichment.* Acenaphthylene is a 3-ring PAH present at low concentrations in crude petroleum compared to phenanthrene. Anthracene is also present at low concentrations in petroleum compared to phenanthrene.[62,63] A double-ratio plot of acenaphthylene to phenanthrene versus anthracene to phenanthrene revealed sediment samples enriched in acenaphthylene (attached Figure 28). Samples enriched in acenaphthylene were found within Jefferson Canal Spoil Pile AOI, the lower half (or east side) of Former Star Lake AOI, and near the confluence of Star Lake Canal and Molasses Bayou waterway. Acenaphthylene enriched PAH are not found to a wider extent in Molasses Bayou, supporting a conclusion that PAH found in most of Molasses Bayou are influenced by a source distinct from upstream sediments that have impacted Jefferson Canal, the Spoil Pile, and Lower Star Lake AOIs.

[62] Douglas, G.S., Emsbo-Mattingly, S.D., Stout, S.A., Uhler, A.D., and McCarthy, K.J. Hydrocarbon Fingerprinting Methods. *Introduction to Environmental Forensics*, *3rd Edition*.

[63] Stogiannidis, E. and Laane, R. (2015). Source Characterization of Polycyclic Aromatic Hydrocarbons by Using Their Molecular Indices: An Overview of Possibilities. In *Reviews of Environmental Contamination & Toxicology*. Springer International Publishing. pp. 49-133.

Basic hydrocarbon chemistry features further identify differences between sediments in Molasses Bayou from upstream sediments in the Jefferson Canal, Jefferson Canal Spoil Pile, and Lower Star Lake AOIs.

1. *Total Petroleum Hydrocarbons (TPH).* TPH is a common metric used in regulatory studies to identify hydrocarbon impacts.[64] Semi-volatile range TPH concentrations (C_6 to C_{35} carbon range) were measured in sediments as part of the RI. The spatial distribution of TPH values at the Site are shown in the attached Figure 29. Elevated TPH levels are observed in Molasses Bayou waterway and exceed "typical" background levels reported for urban sediments (8 to 2,350 mg/kg).[65] The elevated TPH concentrations noted in Molasses Bayou sediments comport with elevated levels of PAHs. Elevated TPH found in Molasses Bayou shows a petroleum source to Molasses Bayou. That source is —likely the BP/Total Refinery.

2. *Benzene, toluene, ethylbenzene, and xylenes (BTEX).* BTEX are a group of volatile compounds that are abundant in hydrocarbons, notably crude oil and many petroleum products.[66] BTEX is another common metric used in regulatory studies to identify petroleum hydrocarbon impacts.[67] Elevated BTEX concentrations were detected in certain sediments at the Site, primarily in Molasses Bayou waterway (attached Figure 30). BTEX chemicals are highly water soluble, and biodegrade rapidly.[68] Thus, their discovery in sediments is unusual, and their presence in sediments suggests recent releases/impacts of petroleum. The findings of BTEX in Molasses Bayou sediments strongly suggests proximity to an on-going source of hydrocarbons (and by extension PAH) to Molasses Bayou. Again, a likely source of these BTEX chemicals is the BP/Total Refinery.

4.4 CDM Smith Did Not Recognize Unique PCB Patterns That Point to Contribution from the BP/Total Refinery to the Site

CDM Smith inappropriately relies upon a single PCB congener, PCB 126, as a marker for the source of PCB contamination to Molasses Bayou. CDM Smith carried out a spatial analysis of the concentration trend for PCB 126 in a limited number of Molasses Bayou sediments. CDM Smith—through analysis of small subset of samples—claimed a "consistent first order decay" in PCB 126 sediment concentration from the intersection of Star Lake Canal with the Left Prong of Molasses Bayou to downstream sampling stations. Based on this trend, CDM Smith concluded that "a lack of a spike in concentration at and

---

[64] Zemo, D.A., Bruya, J.E., and Graf, T.E. (1995). The Application of Petroleum Hydrocarbon Fingerprint Characterization in Site Investigation and Remediation. *Groundwater Monitoring & Remediation* 15 (2), pp. 147-156.

[65] Stout, S.A., Uhler, A.D., and Emsbo-Mattingly, S.D. (2004). Comparative Evaluation of Background Anthropogenic Hydrocarbons in Surficial Sediments from Nine Urban Waterways. *Environmental Science & Technology* 38 (11), pp. 2987-2994.

[66] Uhler, A.D., McCarthy, K.J., Emsbo-Mattingly, S.D., Stout, S.A., and Douglas, G.S. (2010). Predicting Chemical Fingerprints of Vadose Zone Soil Gas and Indoor Air from Non-Aqueous Phase Liquid Composition. *Environmental Forensics* 11 (4), pp. 342-354.

[67] Battelle Prepared for Massachusetts Department of Environmental Protection Office of Research and Standards. September 2007. Sediment Toxicity of Petroleum Hydrocarbon Fractions.

[68] Borden, R.C., Daniel, R.A., LeBrun, L.E., and Davis, C.W. (1997). Intrinsic biodegradation of MTBE and BTEX in a gasoline-contaminated aquifer. Water Resources Research 33 (5), pp. 1105-1115.

downstream of MB-56 does not support the notion that a reservoir of PCB 126 contamination is present in the Right Prong, contributing mass to the Left Prong. The extent of PCB 126 contamination does not support a nexus theory."

CDM Smith's analysis of potential PCB contamination to Molasses Bayou from the BP/Total Refinery via the Right Prong is flawed. There is clear chemical evidence that distinct PCB Aroclor formulations exist in sediments in the vicinity of, and downstream of the historic confluences of the Right Prong with the Left Prong of Molasses Bayou. These PCB Aroclor formulations are different from those found upstream, in the vicinity of the intersection of the Left Prong with the Star Lake Canal. This points to a unique source of PCB to Molasses Bayou from the Right Prong and originating at the BP/Total Refinery. The basis for the SLCCP's position is presented below.

PCB congener 126 is a poor marker for tracking PCB concentration trends and identifying the type of PCB in sediments. PCBs were manufactured by Monsanto and marketed in the United States as Aroclors between 1930 and 1979. Each Aroclor was composed of varying mixtures of 209 related chemicals referred to as PCB congeners. Each of the 209 congeners are composed of a biphenyl molecule with between 1 and 10 chlorine atoms attached to the biphenyl molecule. Different commercial Aroclors contained different proportions of total chlorine, and thus, different proportions of PCB congeners. The most common commercial Aroclors included Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260. The nomenclature used to identify the Aroclor describes the total chlorine content of the mixture. For example, Aroclor 1242 is composed of 42% chlorine by weight; Aroclor 1248 is composed of 48% chlorine by weight, etc.

PCB can be measured as total Aroclor equivalents, or as the sum of individually measured PCB congeners. Both analysis techniques have certain advantages. For example, conventional Aroclor analysis provides a convenient means of identifying the primary Aroclor(s) that compose a sample. Congener analysis offers a means to measure the 209 individual chemicals that theoretically comprise an Aroclor. Such congener-specific information is useful to toxicologists, since there are significant differences in the toxicity of individual PCB congeners.

While congener data are of utility to environmental scientists, the use of single PCB congener as a tracer for PCB contamination is unconventional and provides no insight into the true composition of the PCB or the total concentration of Aroclors found in the environment. Using a single PCB congener as a tracer for total PCB (i.e., Aroclor) concentration is problematic, because (as stated above) individual congeners occurs in significantly different relative concentrations among the commercial Aroclor formulations. With respect to CDM Smith's use of PCB 126 as an indicator of PCB concentration trends: EPA reports a 260-fold difference in relative concentration of PCB 126 among common Aroclors.[69] The Site RI has identified the presence of several different Aroclors in Molasses Bayou. Thus, it was inappropriate and

[69] Rushneck, D.R., Beliveau, A., Fowler, B., Hamilton, C., Hoover, D., Kaye, K., Berg, M., Smith, T., Telliard, W.A., Roman, H., Ruder, E., and Ryan, L. (2004). Concentrations of dioxin-like PCB-like congeners in unweathered Aroclors by HRGC/HRMS using EPA Method 1668A. *Chemosphere, 54*(1), 79-87.

misleading for CDM Smith to use a single PCB congener (PCB 126) as a proxy for PCB concentration in Molasses Bayou.

PCB Concentration Trends are More Complex than CDM Smith Portrays. It is noteworthy that CDM Smith relies only on PCB congener data in their nexus analysis, while ignoring the more expansive Aroclor data set that had been reported in the Site RI. Congener measurements were only made on a relatively small number of Molasses Bayou sediment samples (24), as compared to 140 sediments analyzed for Aroclors. When the more expansive Aroclor data set is used, a more complex spatial trend in PCB concentrations is observed in the Left Prong of Molasses Bayou. Attached Figure 31 depicts the concentration distribution of PCB (reported as Aroclors) in the Left Prong of Molasses Bayou. All data, irrespective of depth, are used in this analysis. The inset graph on this figure shows the concentration of PCB as a function of distance downstream from the intersection of Star Lake Canal and the Left Prong. It is clear that there are multiple areas of elevated PCB concentrations in various segments of the Left Prong, ranging from the Star Lake Canal intersection downstream to areas proximal to the historic intersections of the Right Prong with the Left Prong of Molasses Bayou. The inset graph shows that, contrary to CDM Smith's claim, there is no simple "first order" decreasing trend in PCB concentration with distance downstream from the intersection of the Left Prong with Star Lake Canal toward the historic Right Prong intersection. A reasonable explanation for the observed spatial pattern of PCB contamination in the Left Prong of Molasses Bayou is that there are multiple sources of PCB to the waterway, including in the vicinity of the historic Right Prong intersections with the Left Prong.

Spatially Distinct Aroclors in the Left Prong of Molasses Bayou. Further supporting a concept of multiple sources of PCB to Molasses Bayou is the spatial distribution of Aroclor types in the waterway. The Site RI investigation demonstrated that the PCBs found in Molasses Bayou were a mixture of different Aroclor formulations (see Figure 32 at (a). Within this mixture were samples of singular Aroclor composition. Notably, sediments composed only of Aroclor 1254 were found in the vicinity of the intersection of the Left Prong and Star Lake Canal (Figure 32at (b), whereas sediments composed only of Aroclor 1260 were found near and downstream from the historic intersection of the Right Prong with the Left Prong (Figure 32 at (c). This observation supports a concept that the Right Prong was a source of Aroclor 1260 to Molasses Bayou. The BP/Total Refinery is a logical source of the Aroclor 1260 to the Right Prong.

Interestingly, CDM Smith ignored the large data set of Aroclor data reported in the Site RI. Had CDM Smith considered this data, they would have readily recognized the PCB concentration trends and distinct spatial occurrences of Aroclor types that support the concept that the Right Prong is a source of PCB to Molasses Bayou.

In conclusion, based on SLCCP's chemical analysis, there are multiple lines of evidence to suggest BP/Total Refinery discharges contributed to Site contamination, and it is not defensible to rule out the BP/Total Refinery as a source of contamination at the Site.

5. National Wetlands Inventory Information

BP/Total in the CDM Smith Report asserts: "National Wetlands Inventory (NWI) maps are prepared by the US Fish & Wildlife Service using high altitude photographs to analyze visible vegetation, hydrology, and geography in accordance with FWS guidance (USFWS, 1979). The NWI maps are notable in that the Right Prong and the Left Prong are not connected but are displayed as two separate waterways. These maps corroborate the evidence presented above in the analysis of Present-Day Hydrology that the Right Prong drains to the Boat Canal, away from the Site. The NWI maps also show the open water area at the end of the Right Prong that is evidence of starvation of sediments and nutrients. The NWI maps do not support the nexus theory."

Trying to infer hydrologic connectivity from these maps is a misuse of these products. As described on their website, the United States Fish and Wildlife Service's (USFWS) National Wetlands Inventory is "a publicly available resource that provides detailed information on the abundance, characteristics, and distribution of US wetlands. NWI data are used by natural resource managers, within the USFWS and throughout the Nation, *to promote the understanding, conservation and restoration of wetlands*." USFWS carefully points out that the "map products were neither designed nor intended to represent legal or regulatory products." The NWI represents a planning-level tool for the conservation and restoration of wetlands.

In fact, the USFWS 1979 reference (cited by CDM Smith) states, "Precise description of hydrologic characteristics requires detailed knowledge of the duration and timing of surface inundation, both yearly and long-term, as well as an understanding of groundwater fluctuations. Because such information is seldom available, the water regimes that, in part, determine characteristic wetland and deepwater plant and animal communities are described here in only general terms. Water regimes are grouped under two major headings, Tidal and Nontidal." The objective of the mapping exercise is not to identify hydrologic units as CDM Smith suggests, but instead, "the objective of mapping wetlands and deepwater habitats remains to produce medium resolution information on the location, type, size of these habitats."

The CDM Smith Report provides an image capture of the wetlands map for the Site area and presents this as a line of evidence refuting the Nexus theory. This is also quite misleading. The image is a GIS shape layer shown overlain on aerial imagery, but the scale of the image obscures the aerial imagery. By increasing the magnification at the intersection of the Left Prong and the open water area, one can clearly see a connecting channel that was simply not mapped during the NWI process (attached Figure 33). In addition, other open water features can be seen that are incorrectly mapped as wetlands, indicating that these maps are wholly unsuitable for establishing hydrology.

The assertion that the NWI maps represent evidence that invalidates the nexus theory is erroneous. These maps are a medium-level planning tool and are not intended to show detailed hydrology. In addition, they are not intended to represent legal or regulatory products. The use of these maps to attempt to refute the nexus theory is a misapplication of these products.

CONCLUSION

The SLCCP again thanks you for meeting with us on March 14, 2018 and for your invitation to submit this rebuttal letter. The above analysis shows an irrefutable nexus between the BP/Total Refinery and the chemicals of concern at the Site. We urge EPA to request that BP/Total resume discussions with the SLCCP for a share of response costs at the Site.

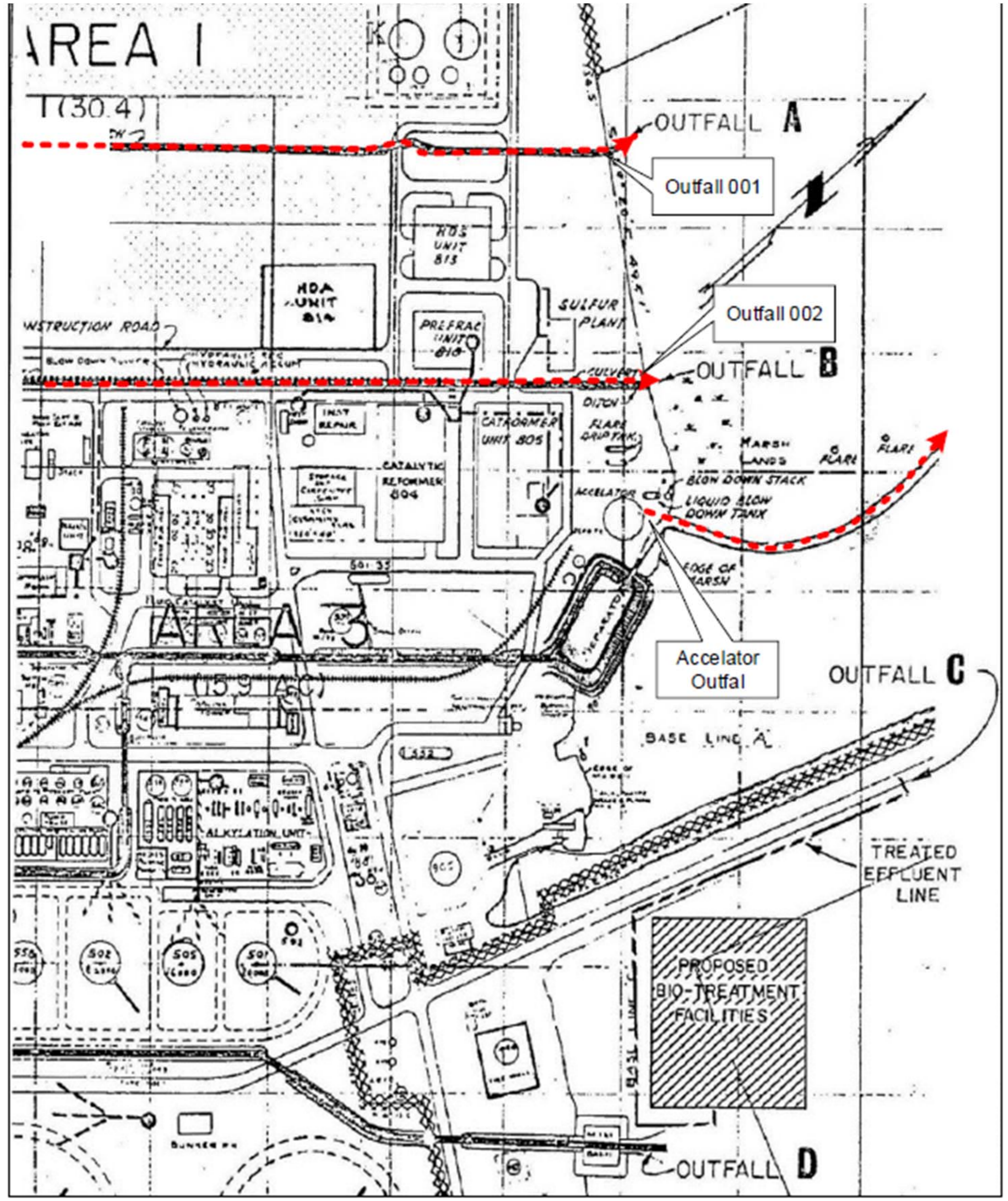
Thank you for your consideration.

Sincerely,

Connie M. Bryan

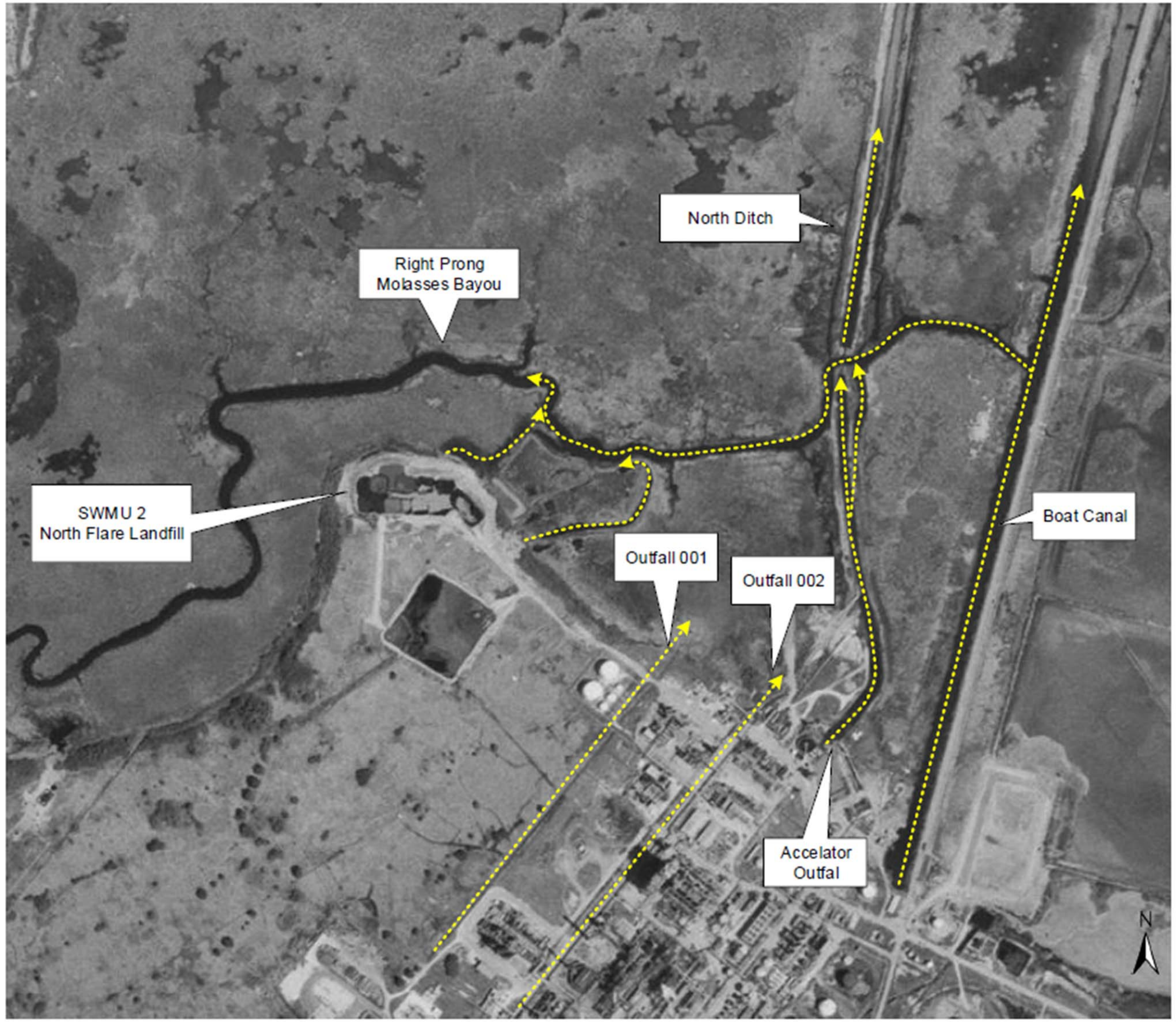
Enclosures

cc: SLCCP Members (via e-mail)



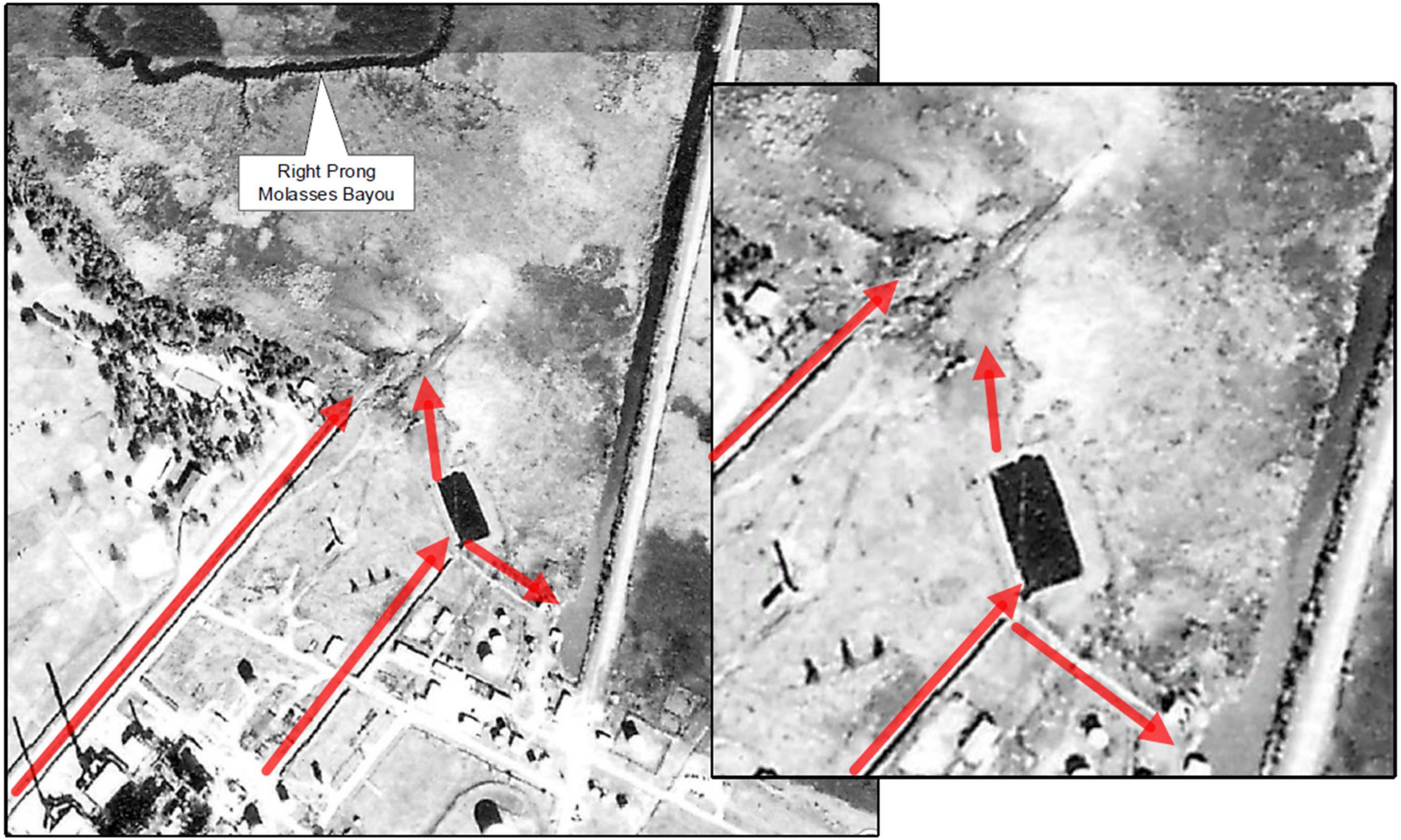
Map dated circa 1969

Figure 1: Pre-Levee Refinery Discharge Pathways



Aerial: USGS, 1970

Figure 2: Pre-Levee Refinery Discharge Pathways



Aerial: Google Earth December 1938

Figure 3: Refinery Discharges Prior to Installation of Separator Canal December 1938 Google Earth

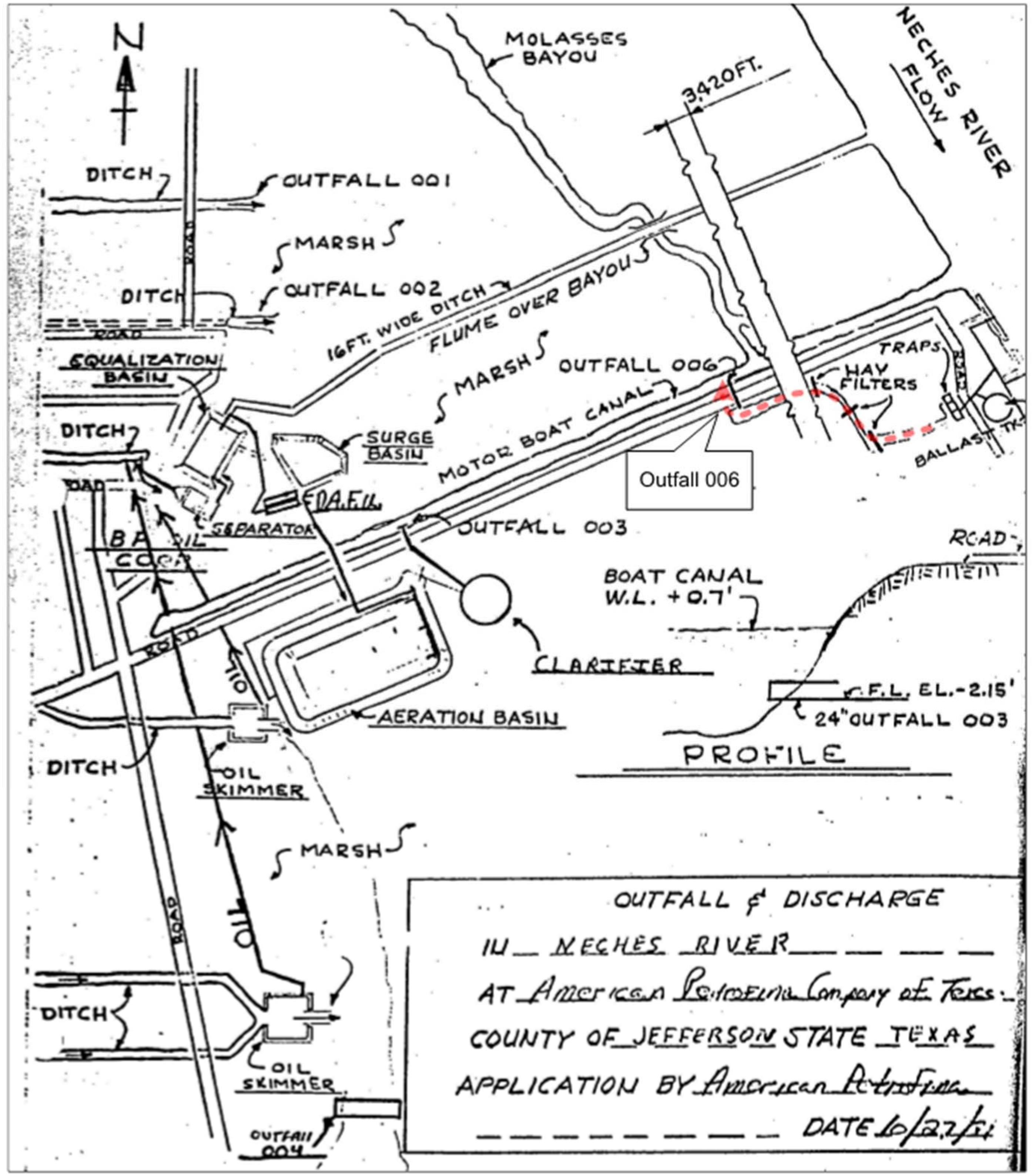


Figure 4: Location of Outfall 006

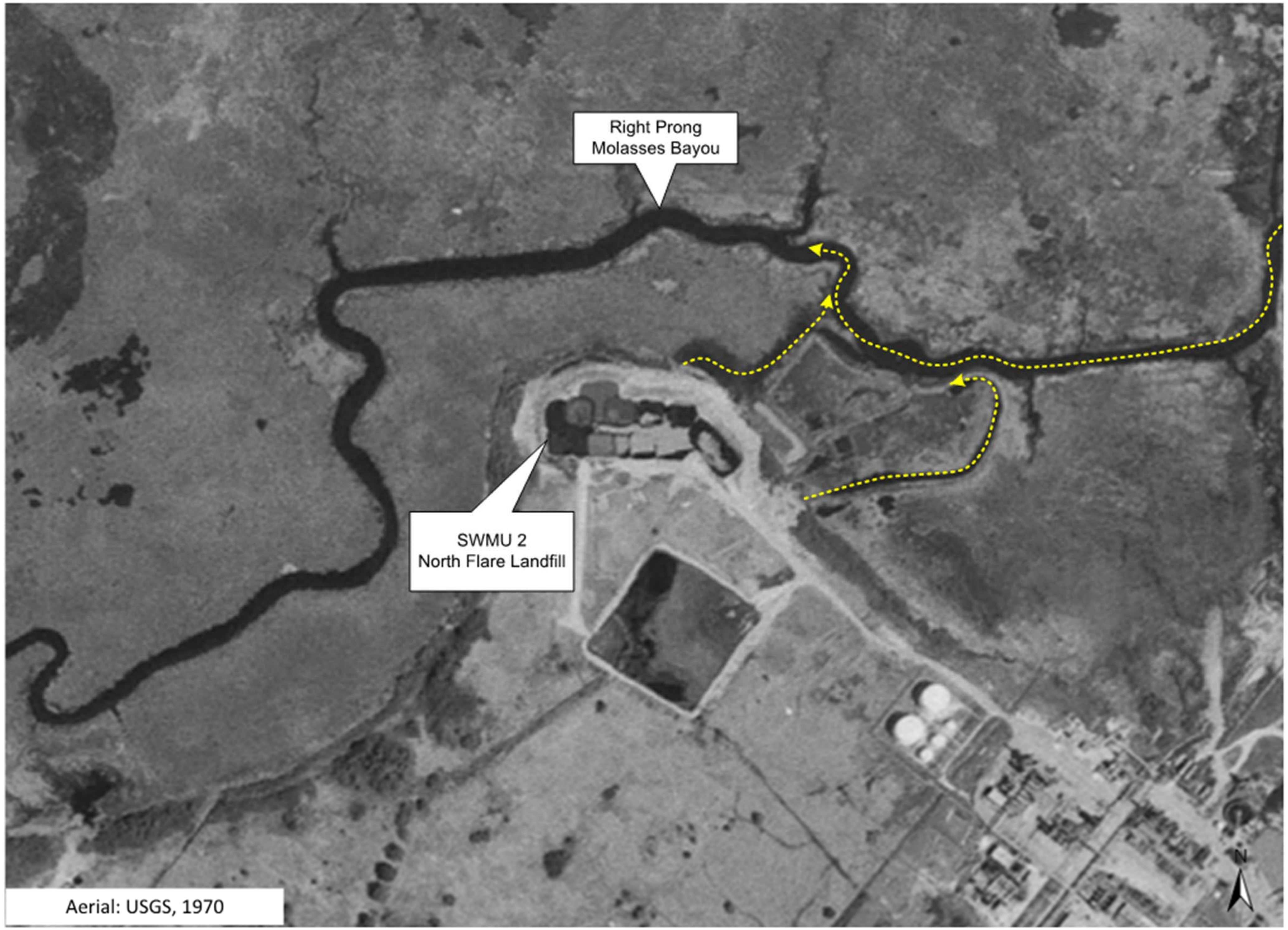
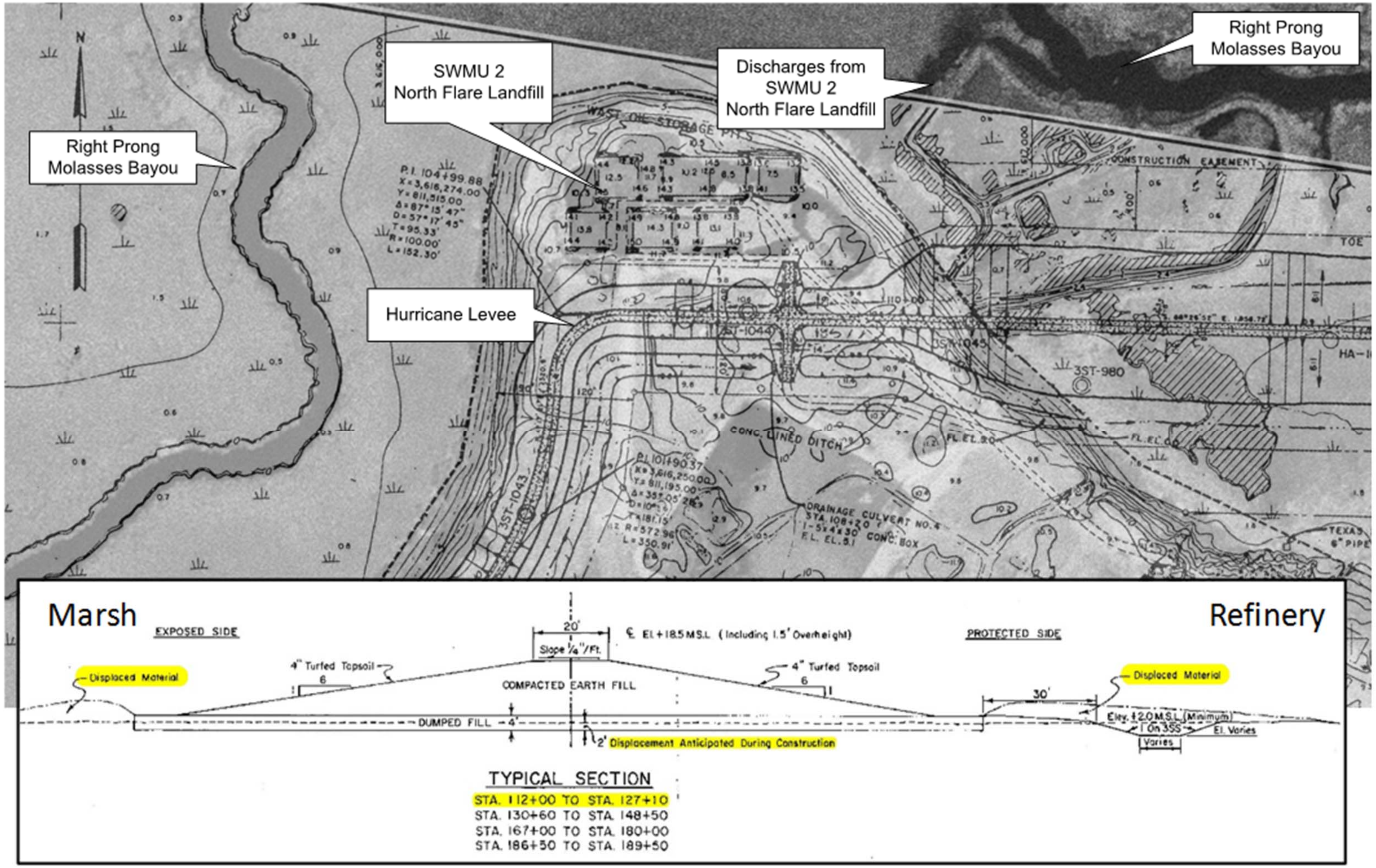
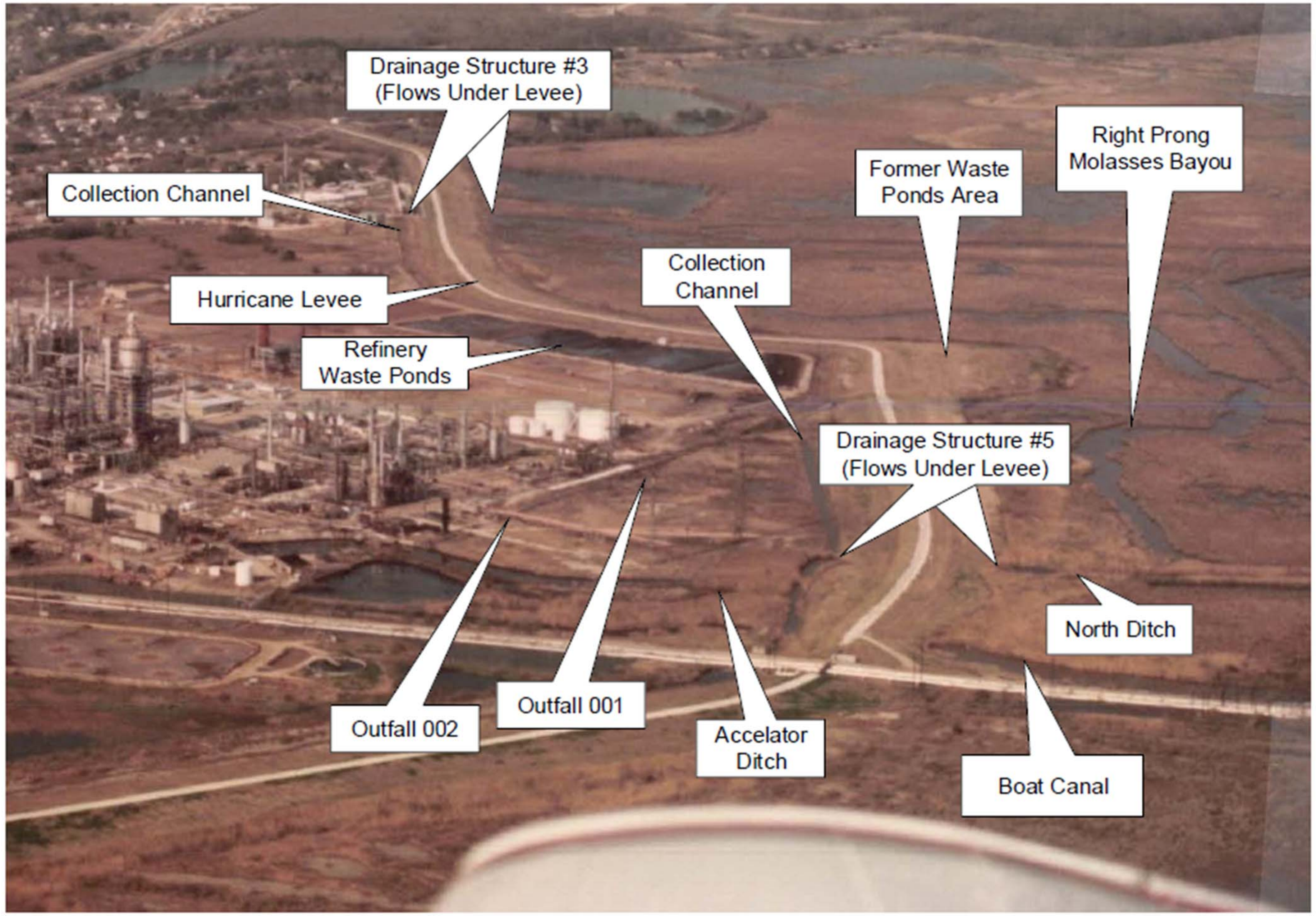


Figure 5: Location of SWMU 2 and North Flare Landfill



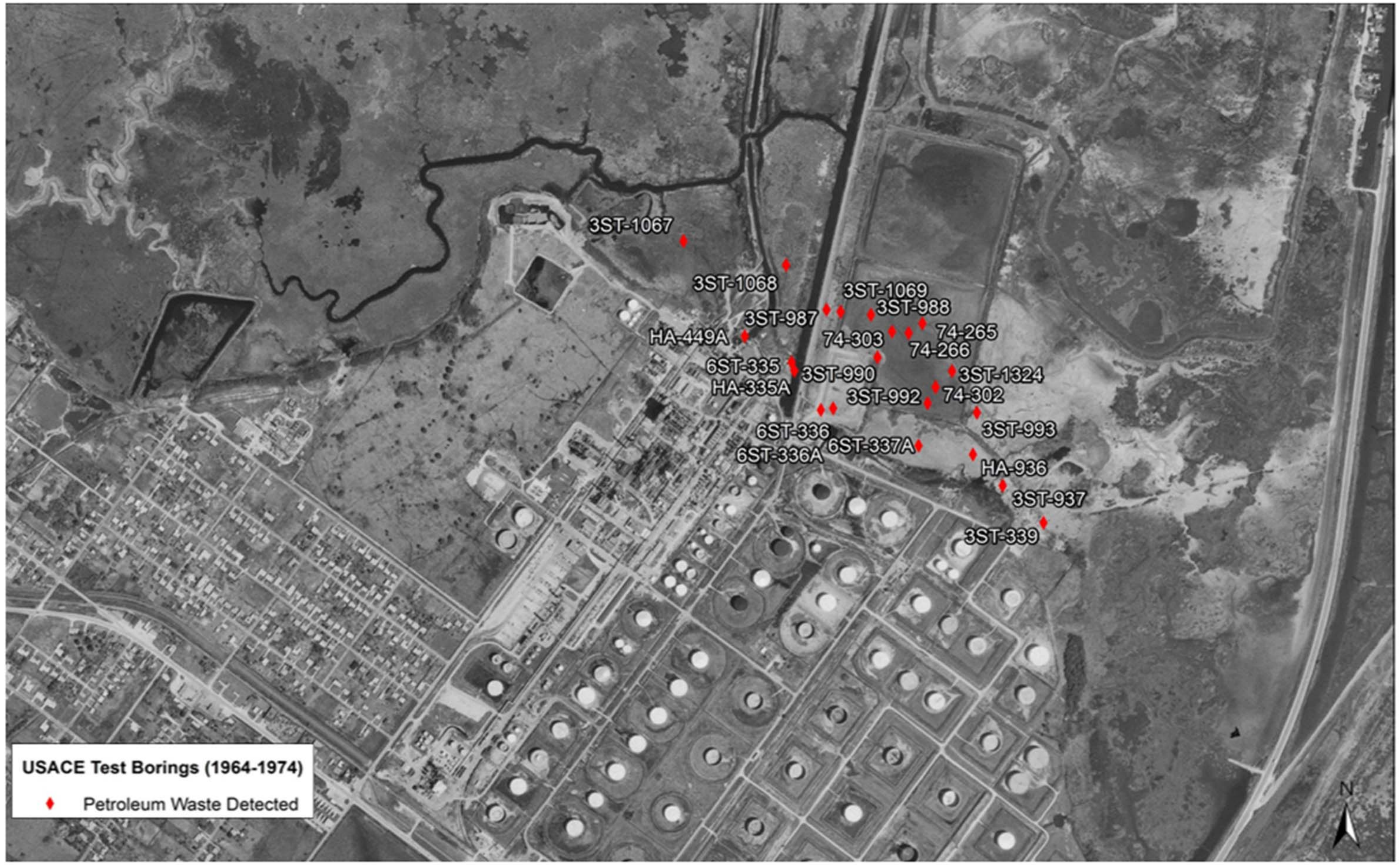
Source: USACE, Design Memorandum No. 2, Supplement No.3, Exhibit B-5

Figure 6: Refinery Waste Ponds Hydraulically Connected to Right Prong of Molasses Bayou and the Marsh



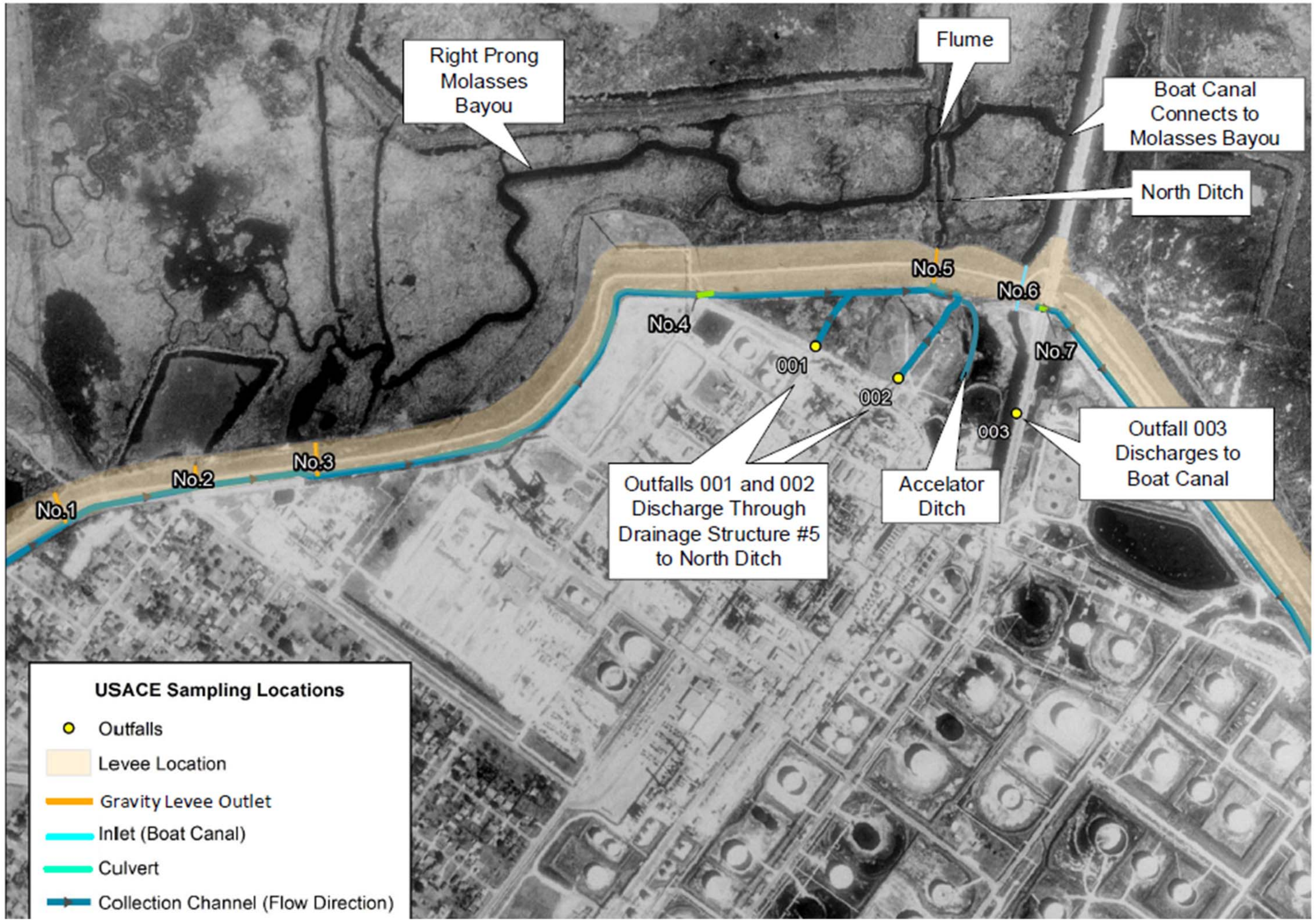
Photograph from Permit Action Package, 1980

Figure 7: Pathways Post Hurricane Levee Construction



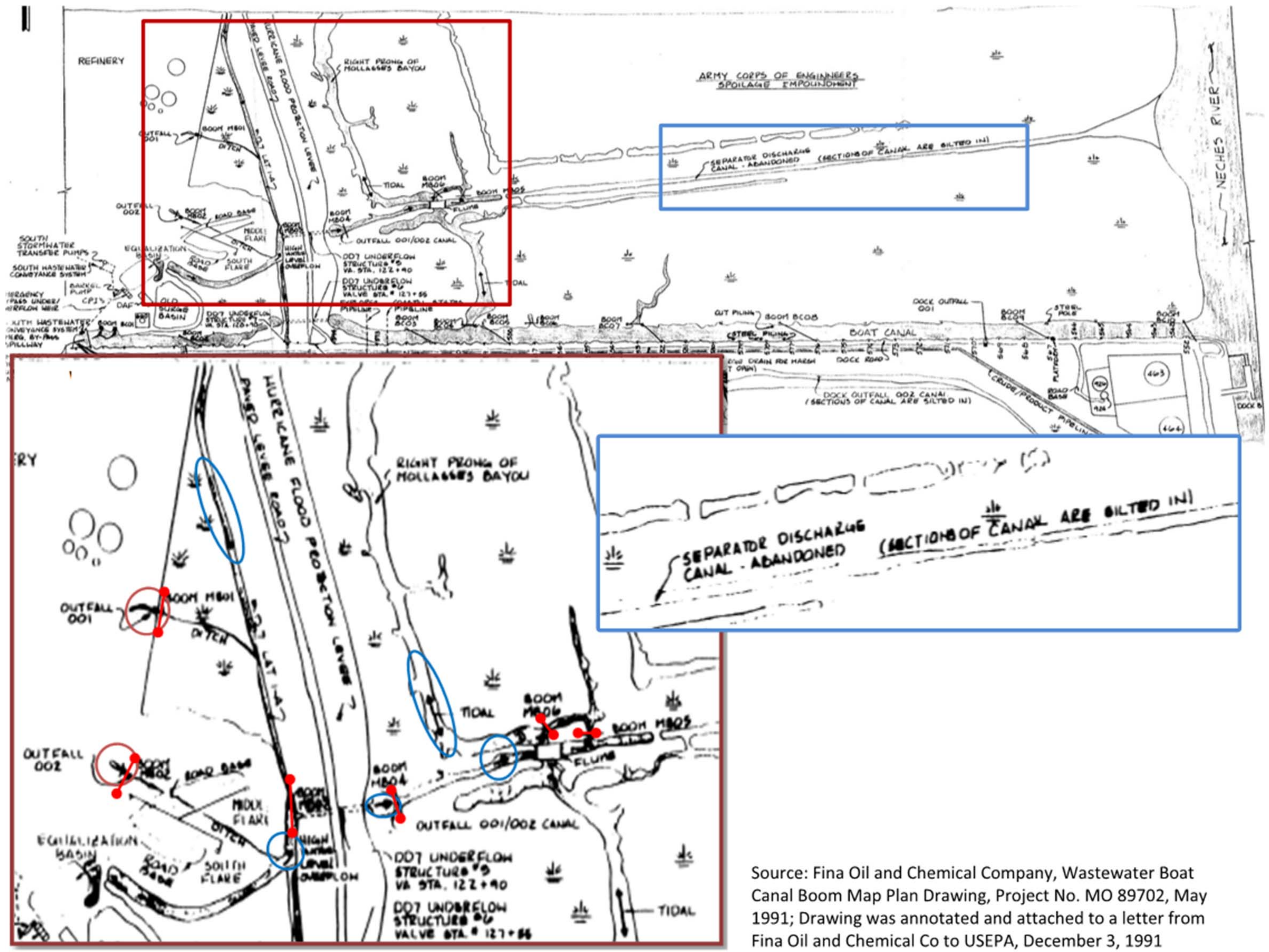
Aerial: USGS Test Borings (1964-1974) Sampling information from USACE, Port Arthur Flood Protection Report No. 1031, 2/9/1966 and DM No. 2 General Design Memorandum, Volume 1

Figure 8: USACE Observations of Petroleum Impacts from Refinery



Aerial Photograph 1989

Figure 9: Pathways Post - Levee Construction



Source: Fina Oil and Chemical Company, Wastewater Boat Canal Boom Map Plan Drawing, Project No. MO 89702, May 1991; Drawing was annotated and attached to a letter from Fina Oil and Chemical Co to USEPA, December 3, 1991

Figure 10: Pathways Post - Levee Construction

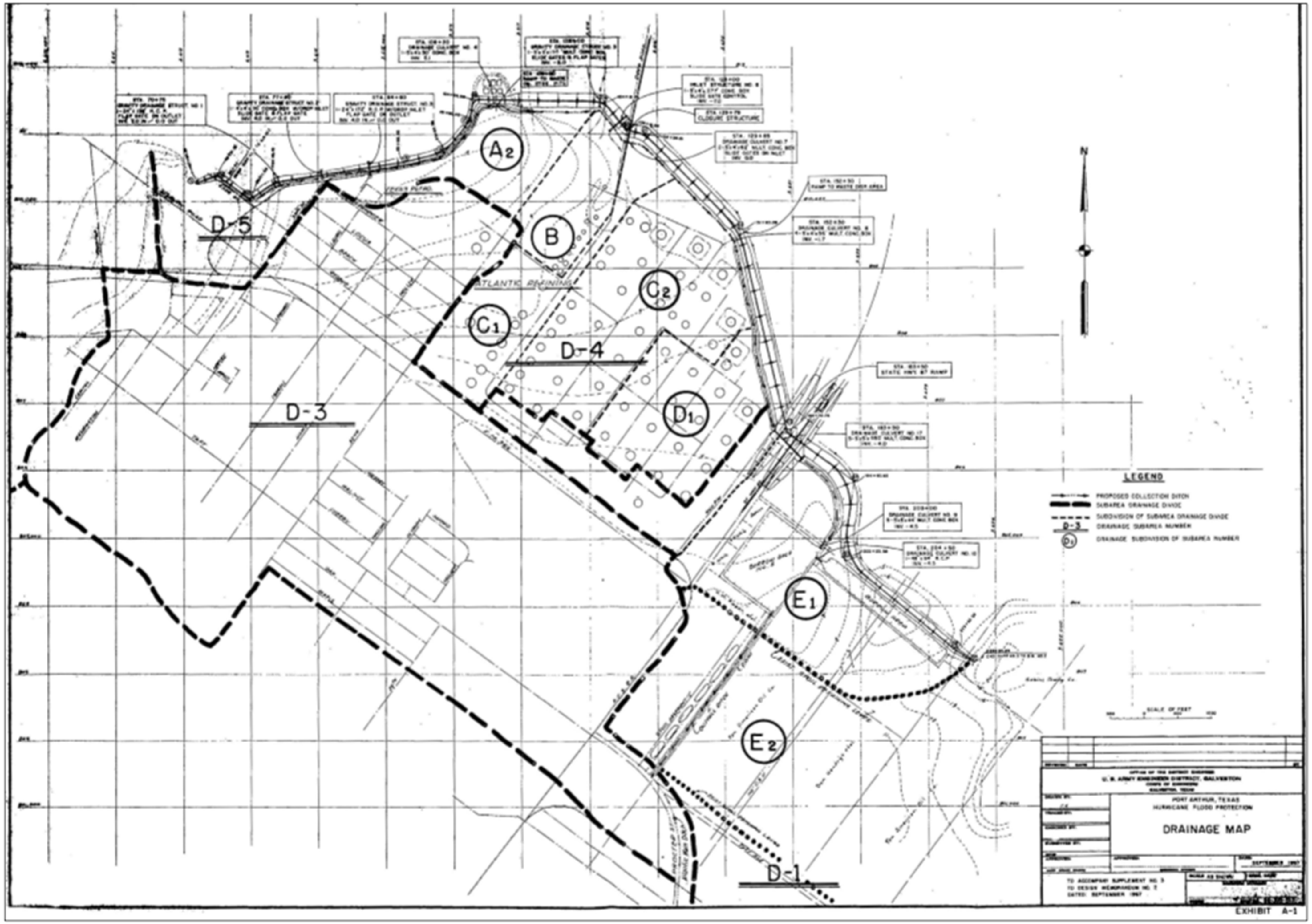
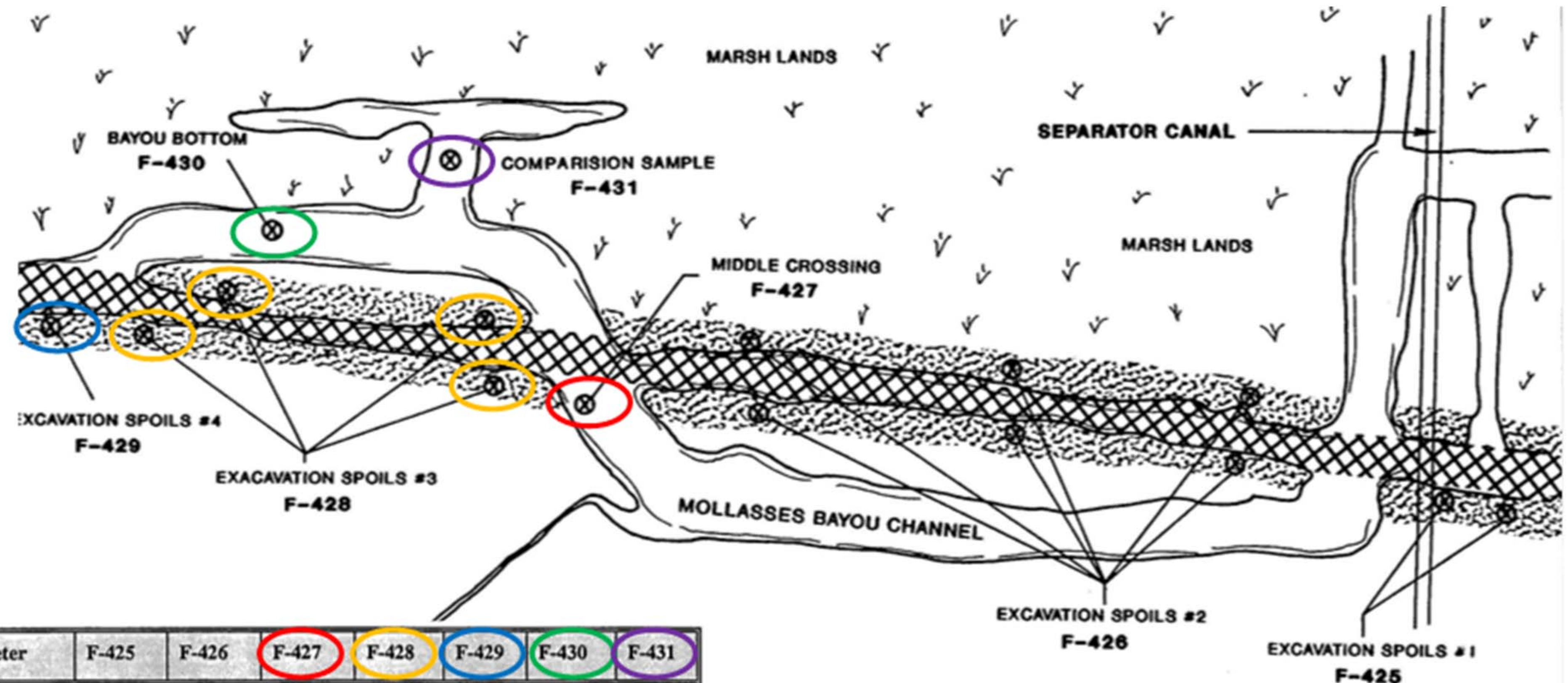


Figure 11: Drainage Areas Post - Levee Construction



Parameter	F-425	F-426	F-427	F-428	F-429	F-430	F-431
TPH	18	42	2,300	50	35	3,700	10
Oil & Grease	40	60	3,500	300	220	1,200	1,900
Total Solids	31.8%	22.3%	NR	46.1%	48.0%	44.1%	25.3%
Solvent Scan	ND	ND	NR	ND	ND	2,500	690

Analytical results in mg/kg
ND = Non-detectable
NR = Not Reported

LEGEND

⊗ SAMPLE LOCATION
EXCAVATION SPOIL FROM PIPE CONSTRUCTION
PIPELINE CONSTRUCTION

SCHEMATIC DRAWING
NOT TO SCALE

BASE MAP REDRAWN FROM ECCO MAP, 1991.

NOTE: ALL LOCATIONS ARE APPROXIMATE.

Source: Jones & Neuse, RCRA Facility Investigation Phase 1 Work Plan for the Separator Canal Fina Oil and Chemical Company, February 1, 1992 (Revised March 1996), pp. 17 and 22.

Figure 12: Right Prong of Molasses Bayou Sampling

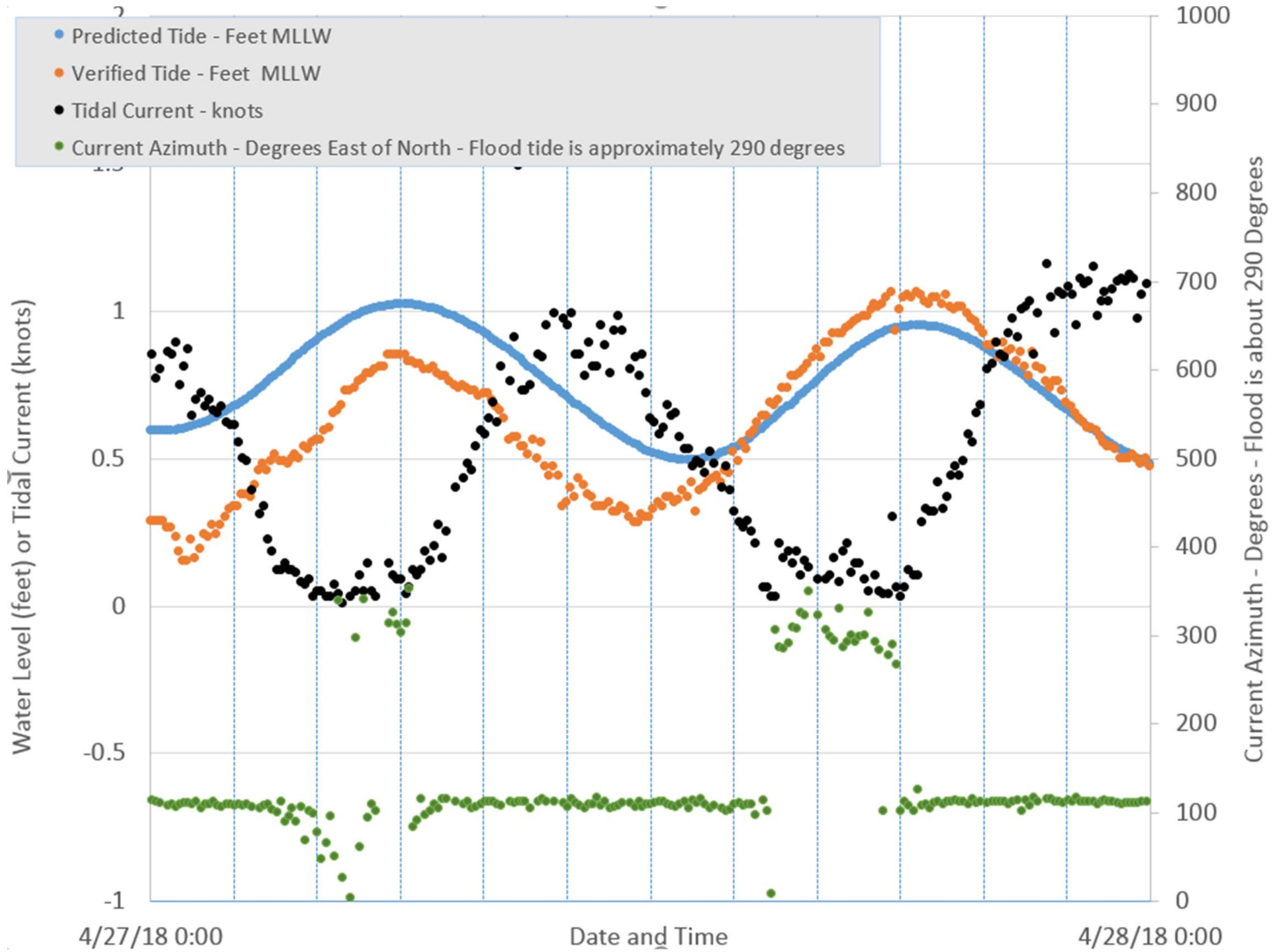
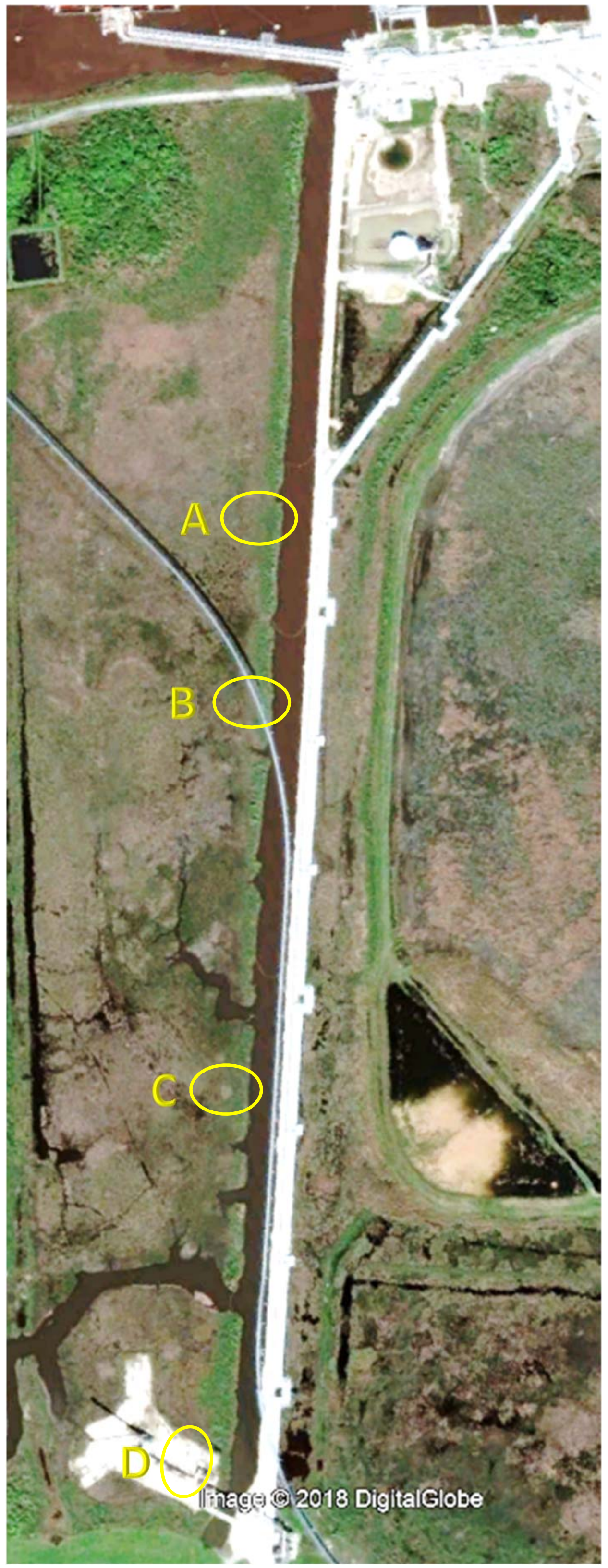


Figure 13: Observed Water Levels and Currents at the Rainbow Bridge Gage



Aerial: March 26, 2015 Google Earth Imagery

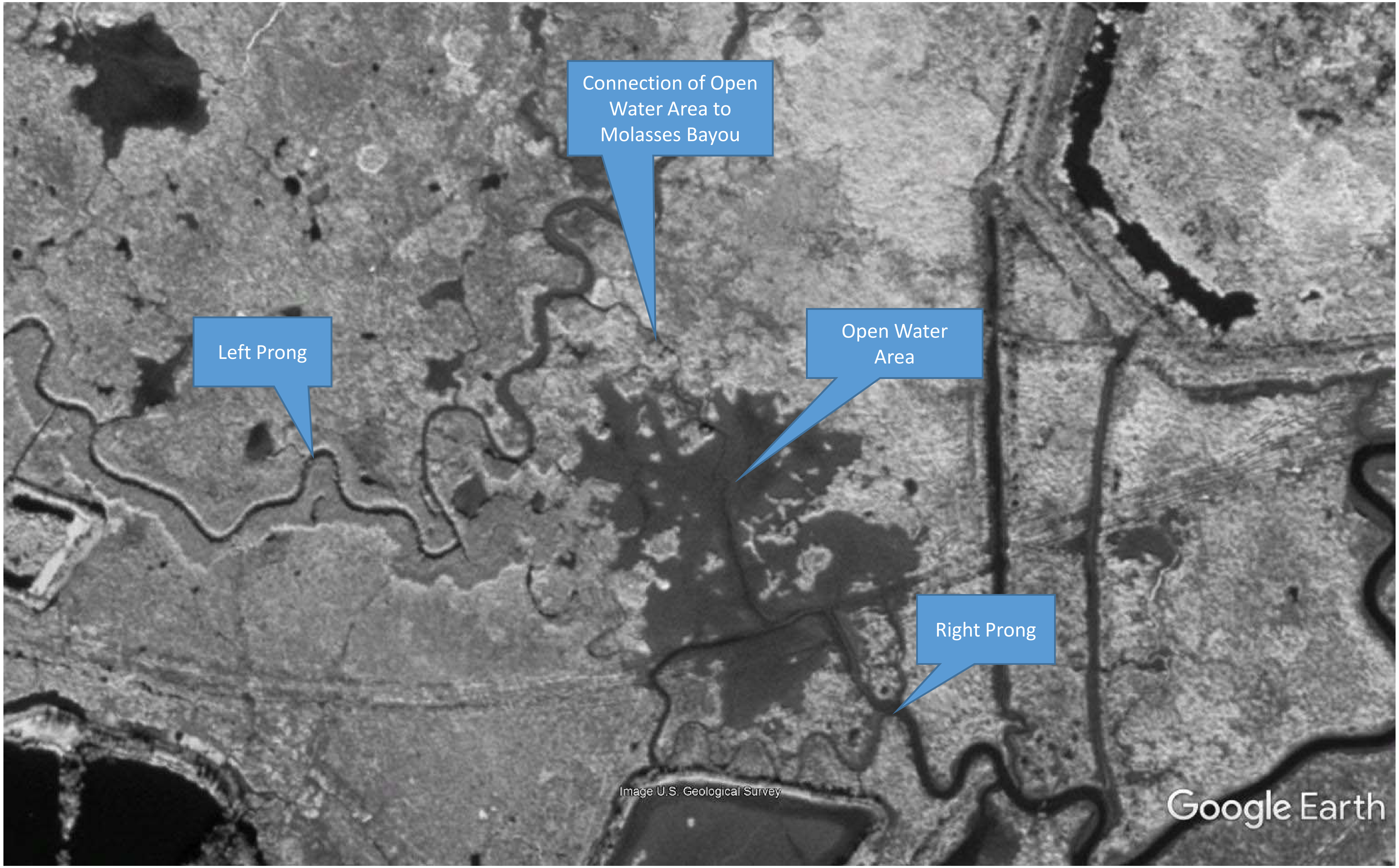
Figure 14: Curvature of Oil Control Booms in the Boat Canal on March 26, 2015

Aerial: January 29, 2017 Google Earth Imagery

Figure 15: Curvature of Oil Control Booms in the Boat Canal on January 29, 2017

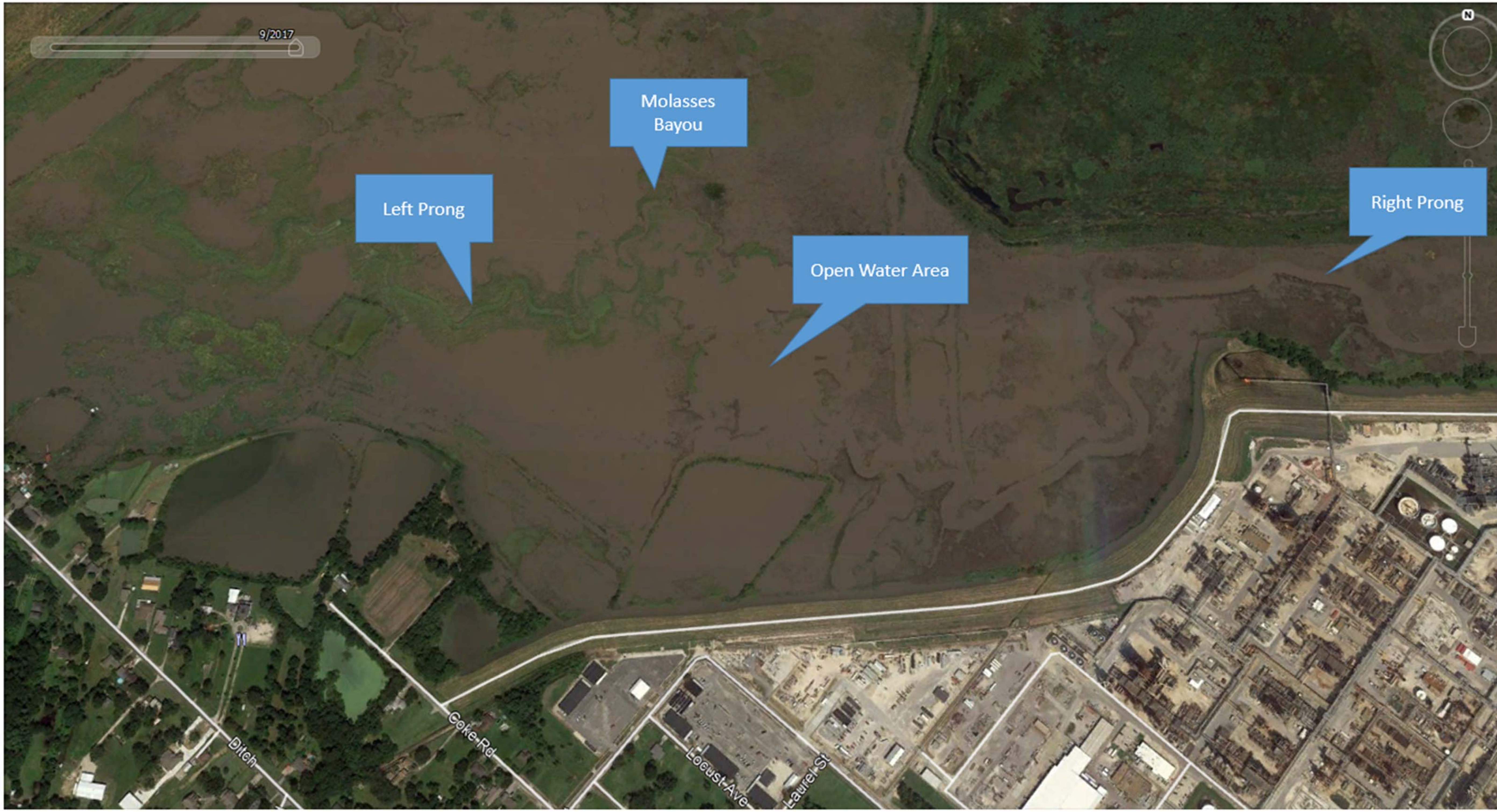
Aerial: October 31, 2006 Google Earth Imagery

Figure 16: 2006 Aerial Photograph



Aerial: January 11, 1996 Google Earth Imagery

Figure 17: 1996 Aerial Photograph



Aerial: September 1, 2017 Google Earth Imagery

Figure 18: High Tide Stages Observed During Hurricane Harvey

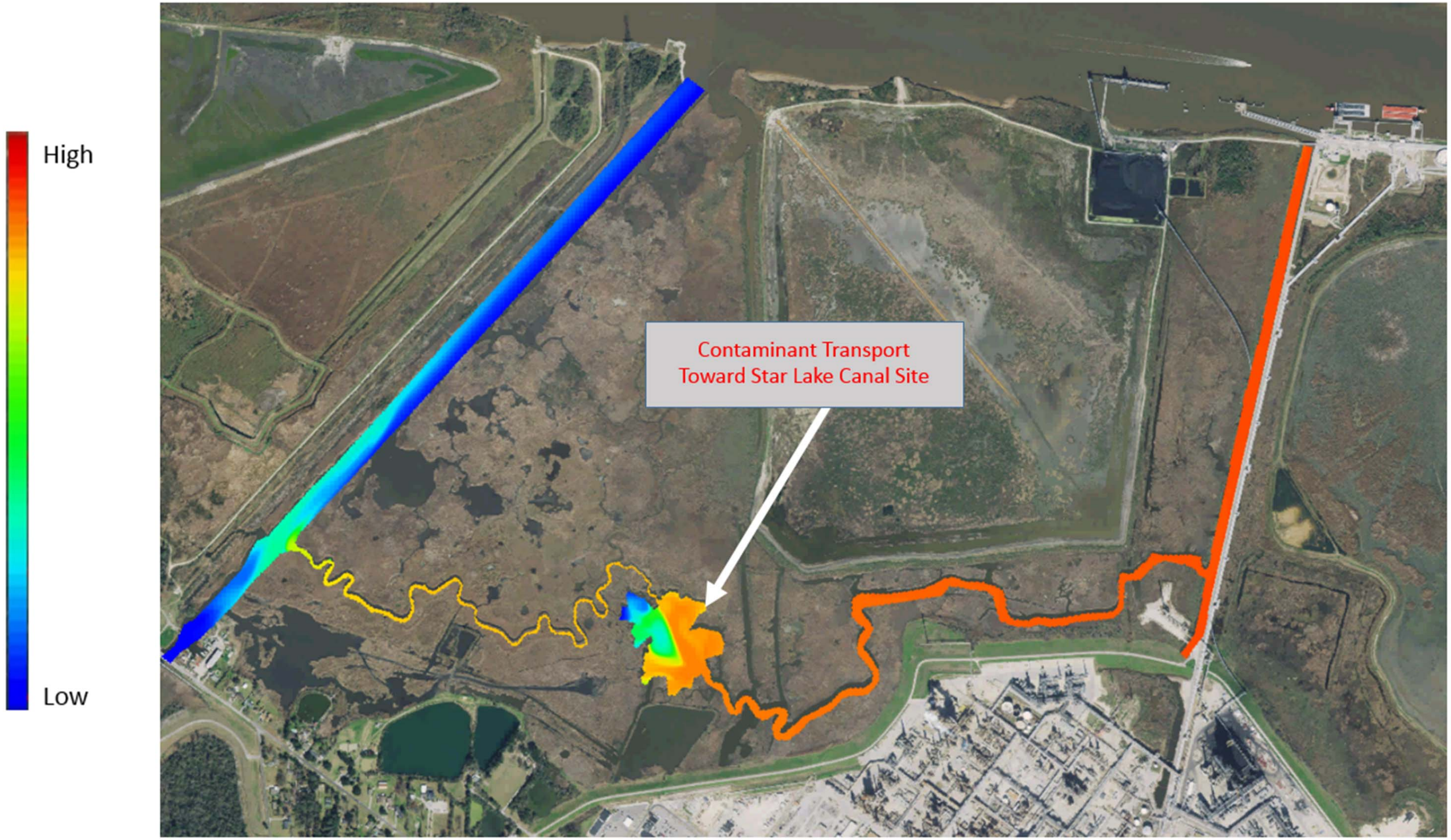
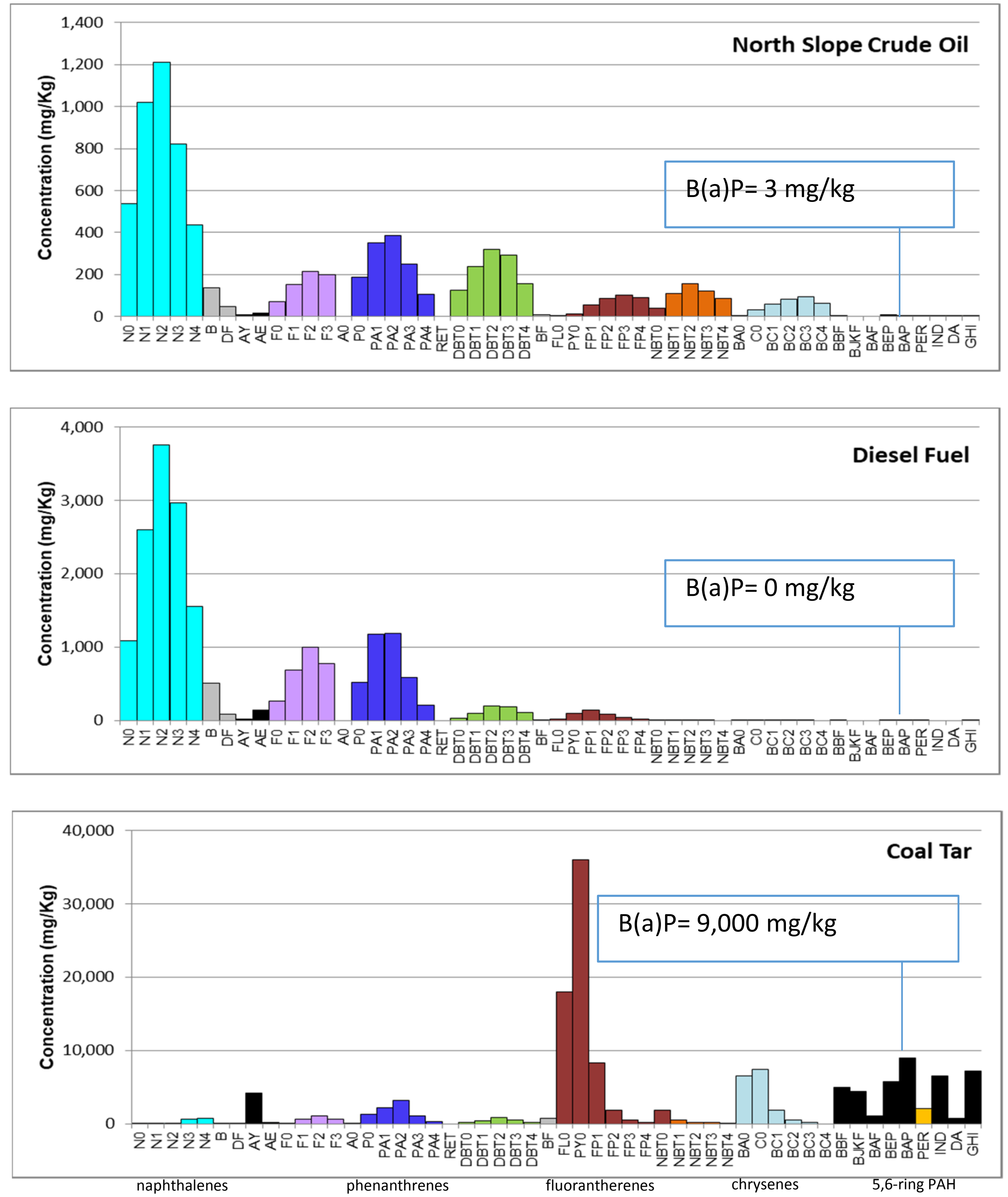
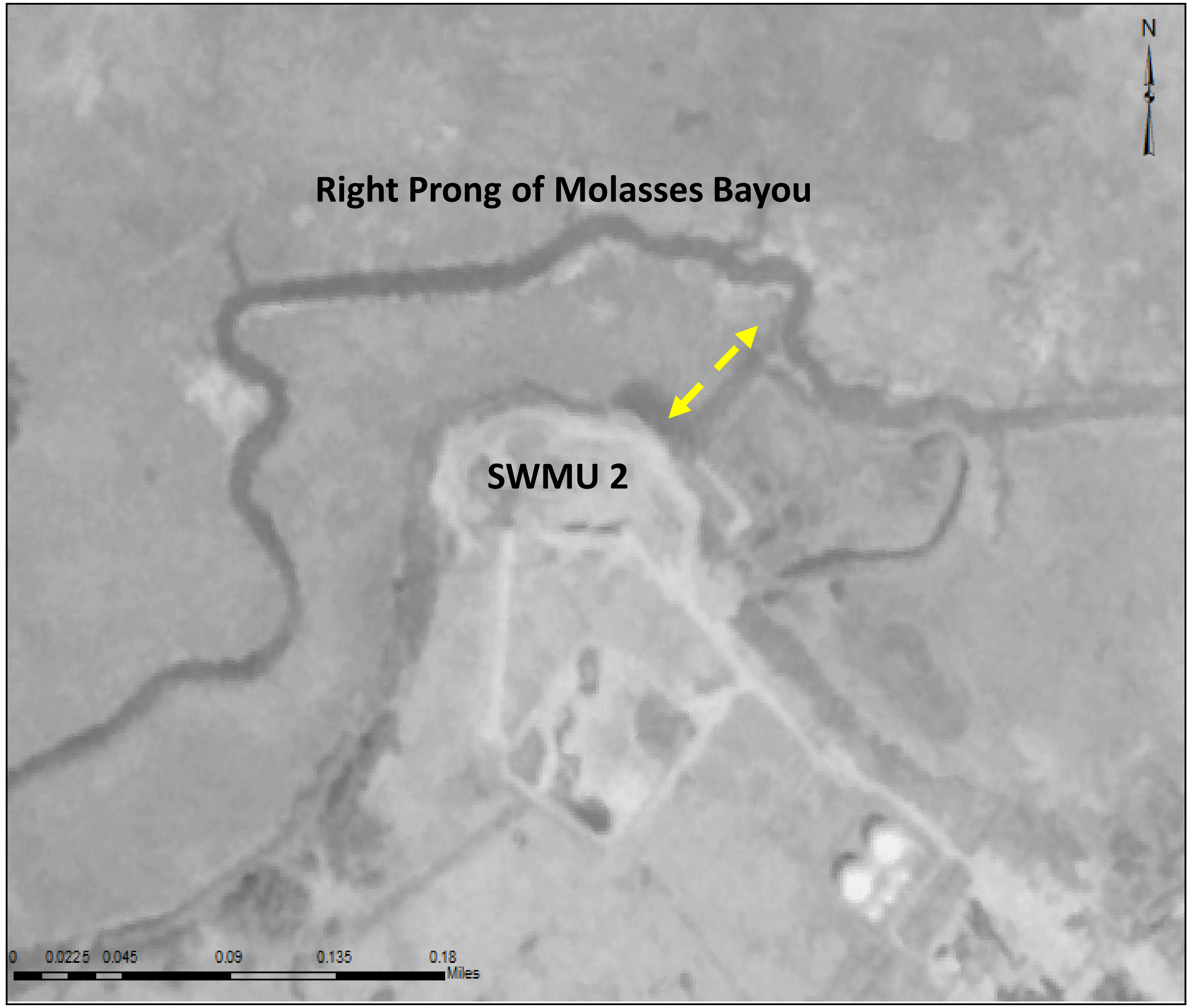


Figure 19: Hydraulic Modeling of the Boat Canal



Note that BaP is prominent in the pyrogenic material, but only occurs in *de minimis* concentrations in the petroleum products.

Figure 20: Comparative PAH Compositional Histograms for Petrogenic Crude Oil and Diesel Fuel versus a Pyrogenic Coal Tar



Hydrologic surface water connections to the Right Prong of Molasses Bayou are evident.

Figure 21: 1970 Aerial Photograph of the BP/Total Refinery North Flare Landfill (SWMU 2)

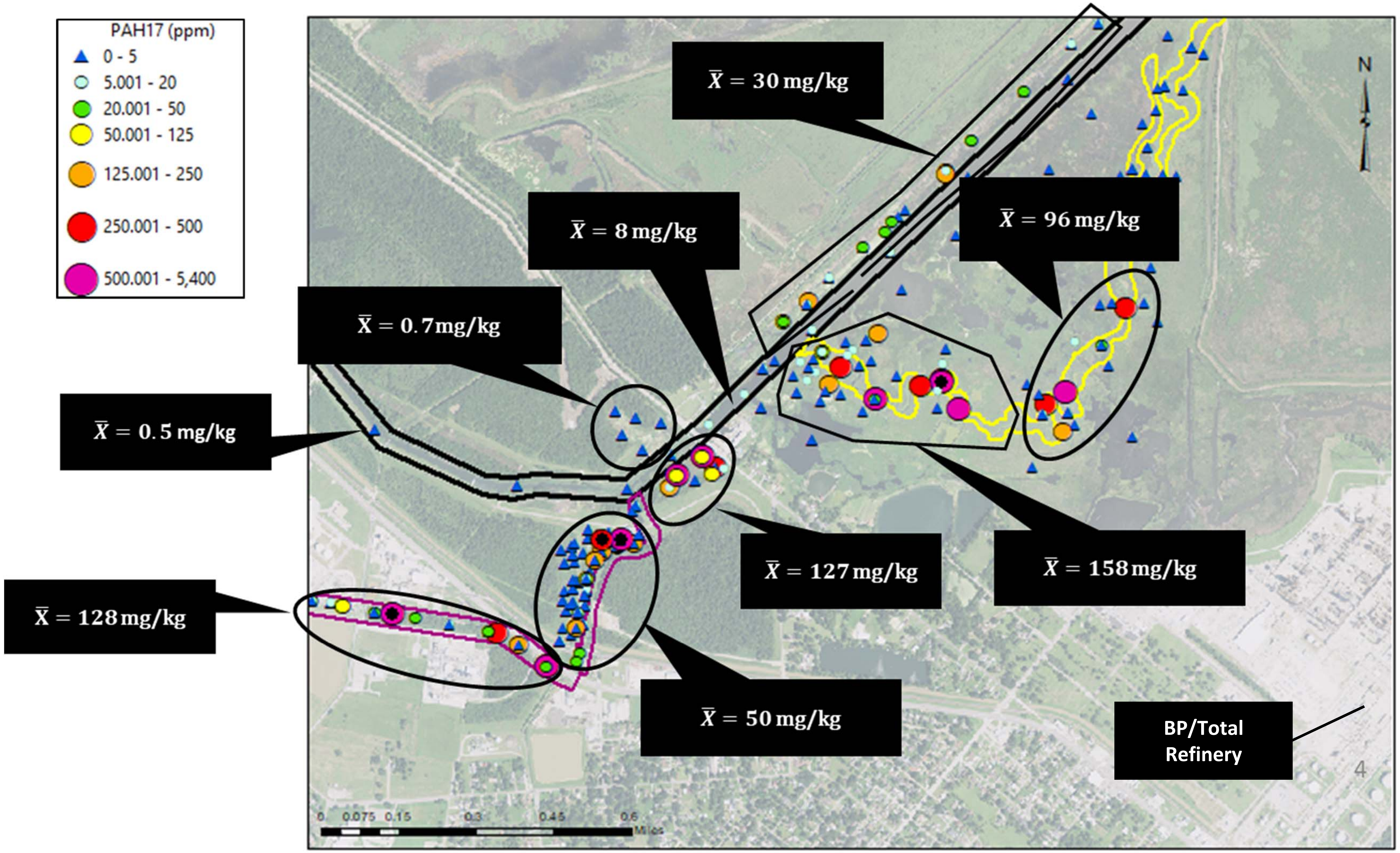


Figure 22: PAH Concentration Distributions in Site Sediments Illustrate a Complex Pattern of PAH, Indicative of Multiple Sources of PAH to the Site

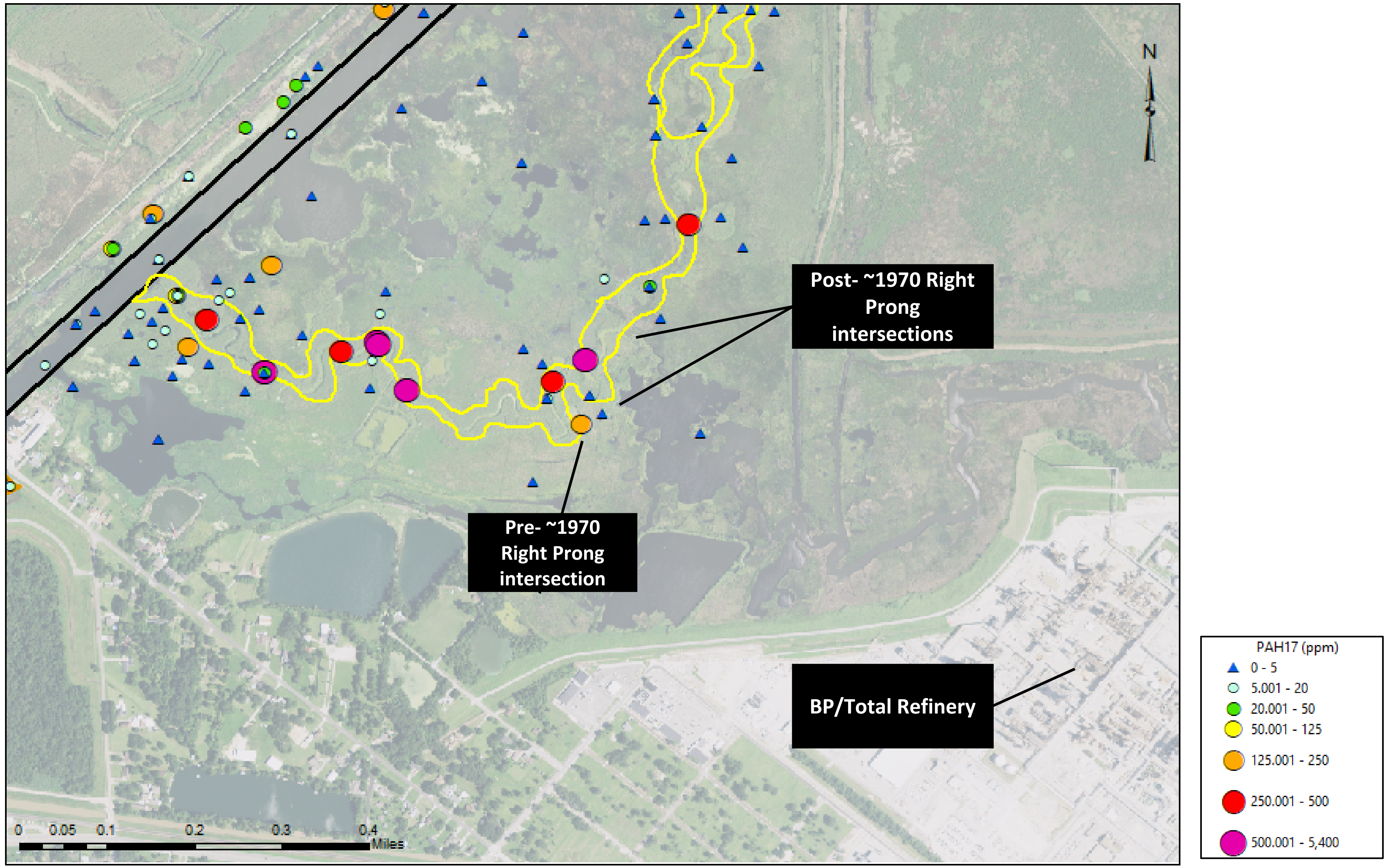


Figure 23: Elevated PAH in Molasses Bayou are Found in the Vicinity of Intersections of the Right Prong with Molasses Bayou Waterway

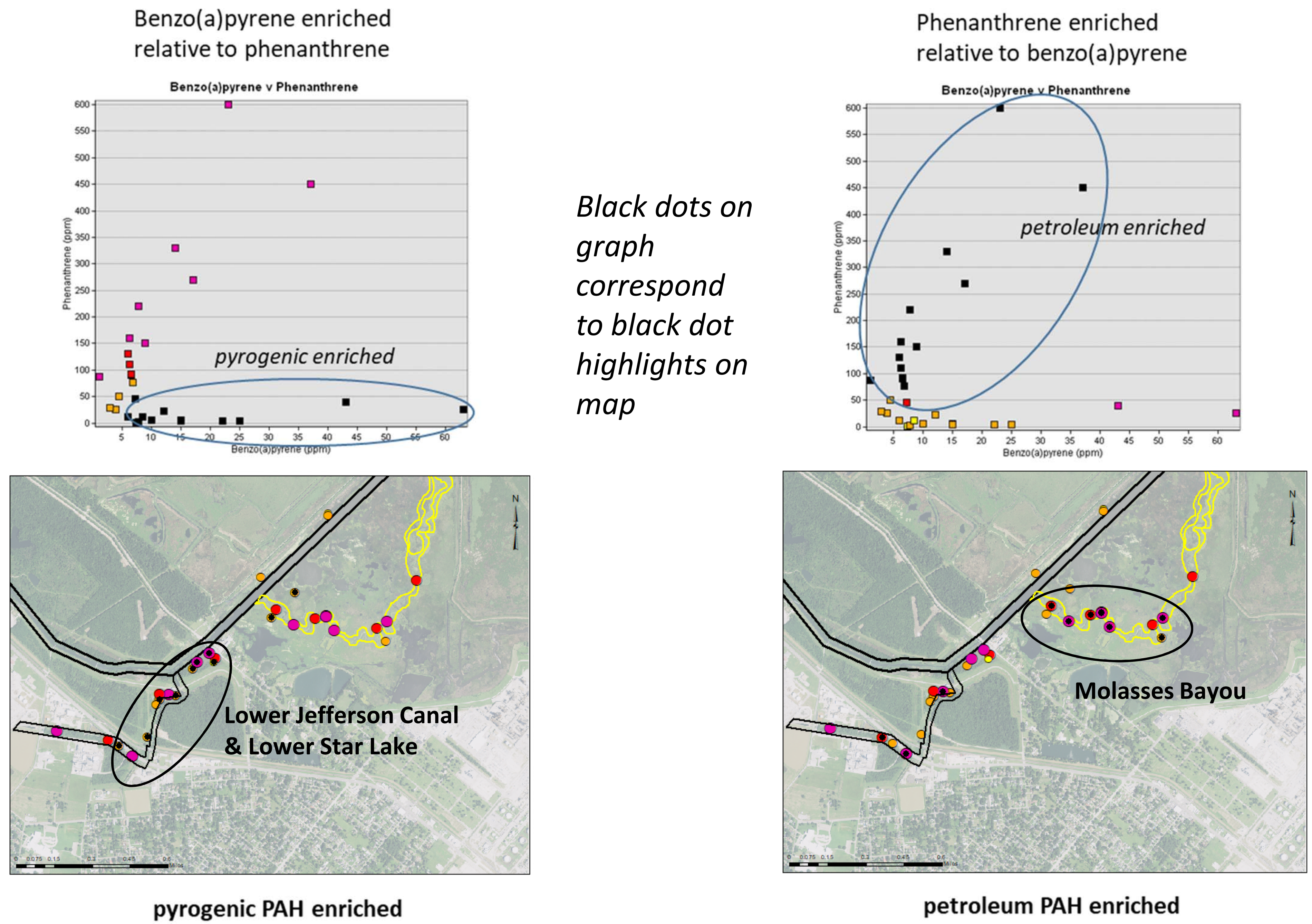
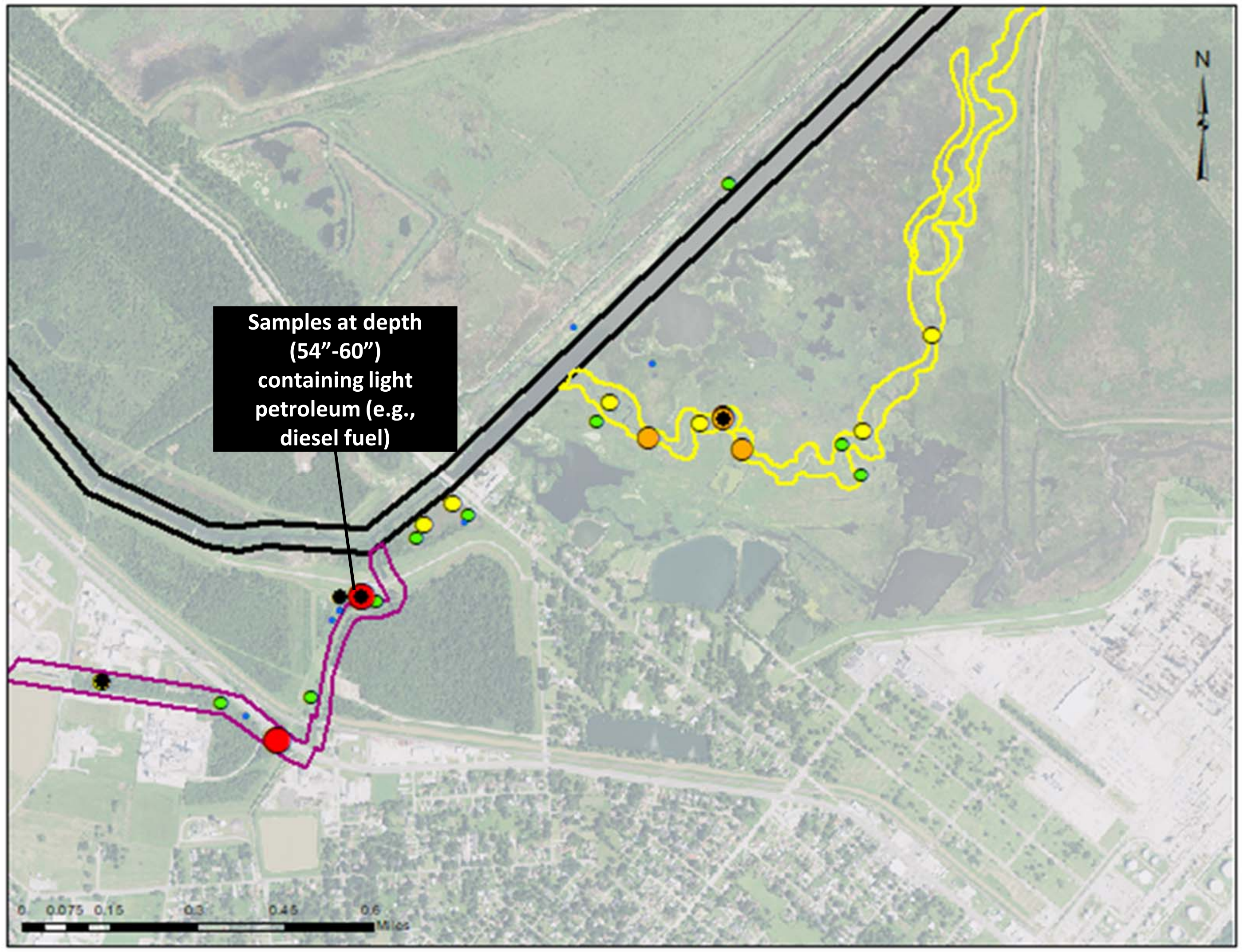
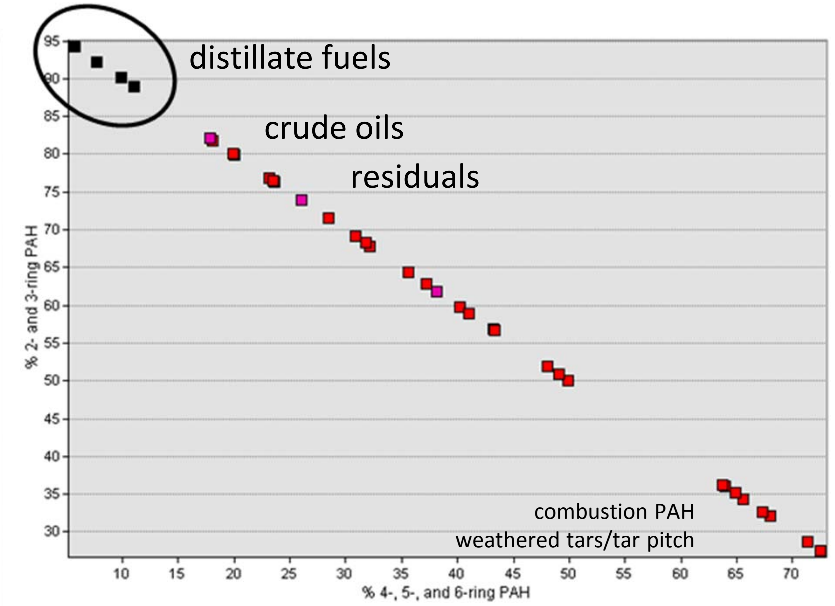


Figure 24: Spatial Differences in PAH Composition are Evident across the Site, Indicative of Multiple Sources of PAH to the Site

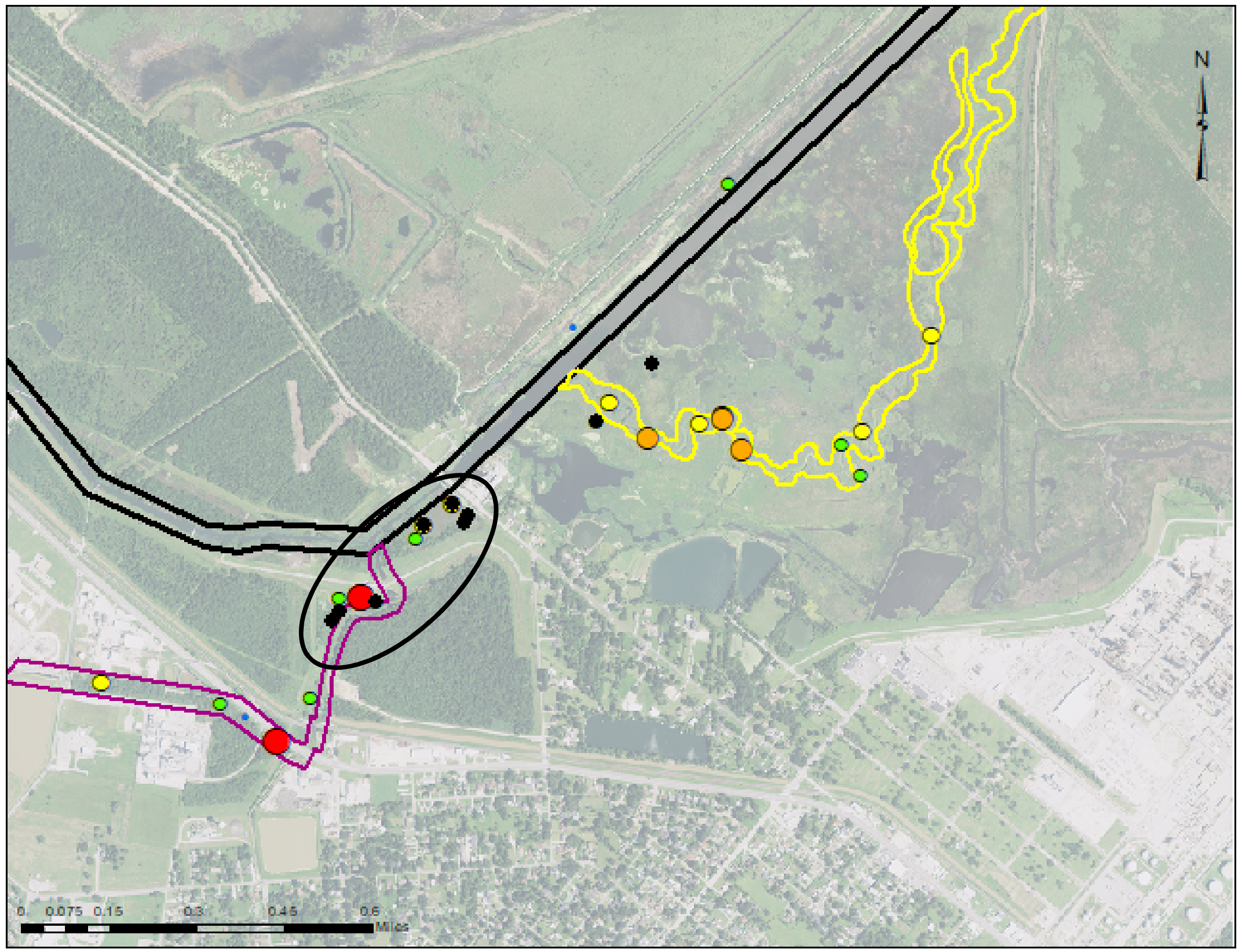


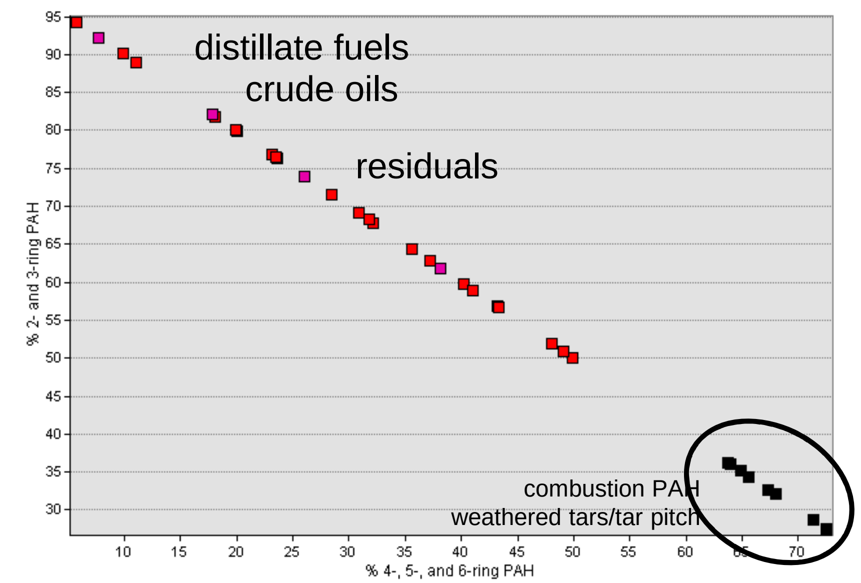


Low molecular weight PAH-dominant samples found only in isolated samples

PAH dominated by 2- and 3-ring PAH found only sporadically at the Site.

Figure 25: Distinct Differences in PAH Composition Reconcile with Geography and Thus Likely Sources

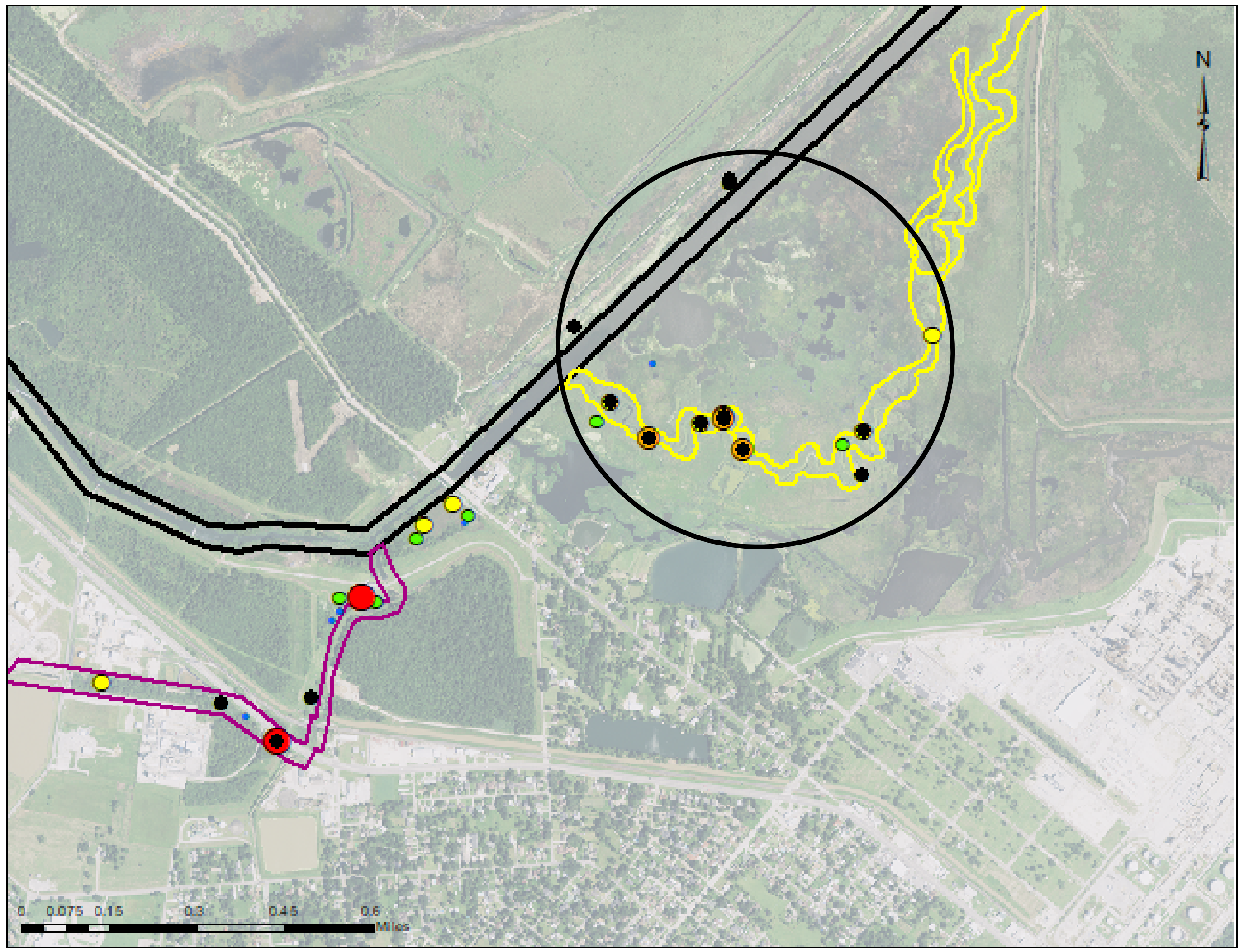


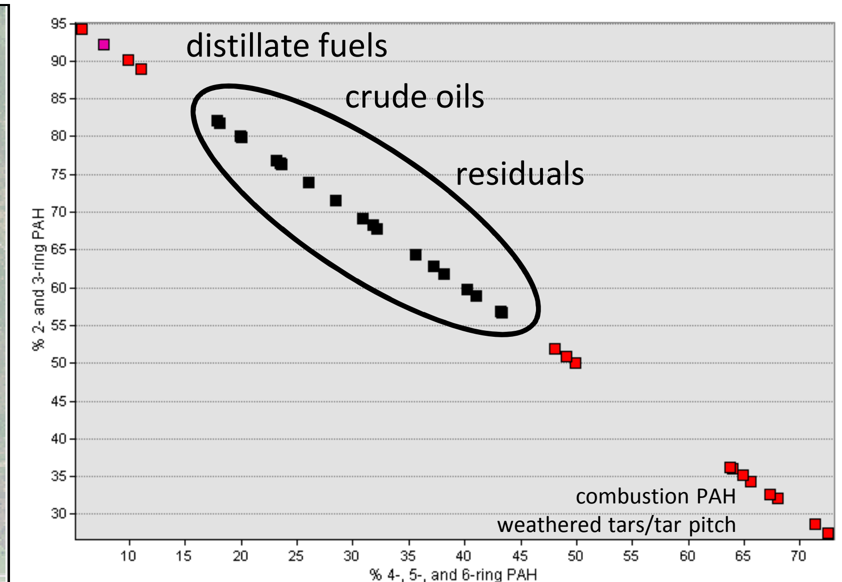


High molecular weight PAH-dominant samples found in Jefferson Canal, Lower Star Lake

PAH dominated by 4-, 5- and 6-ring PAH found primarily in the Jefferson Canal and Star Lake area of the Site.

Figure 26: Distinct Differences in PAH Composition Reconcile with Geography and Thus Likely Sources.

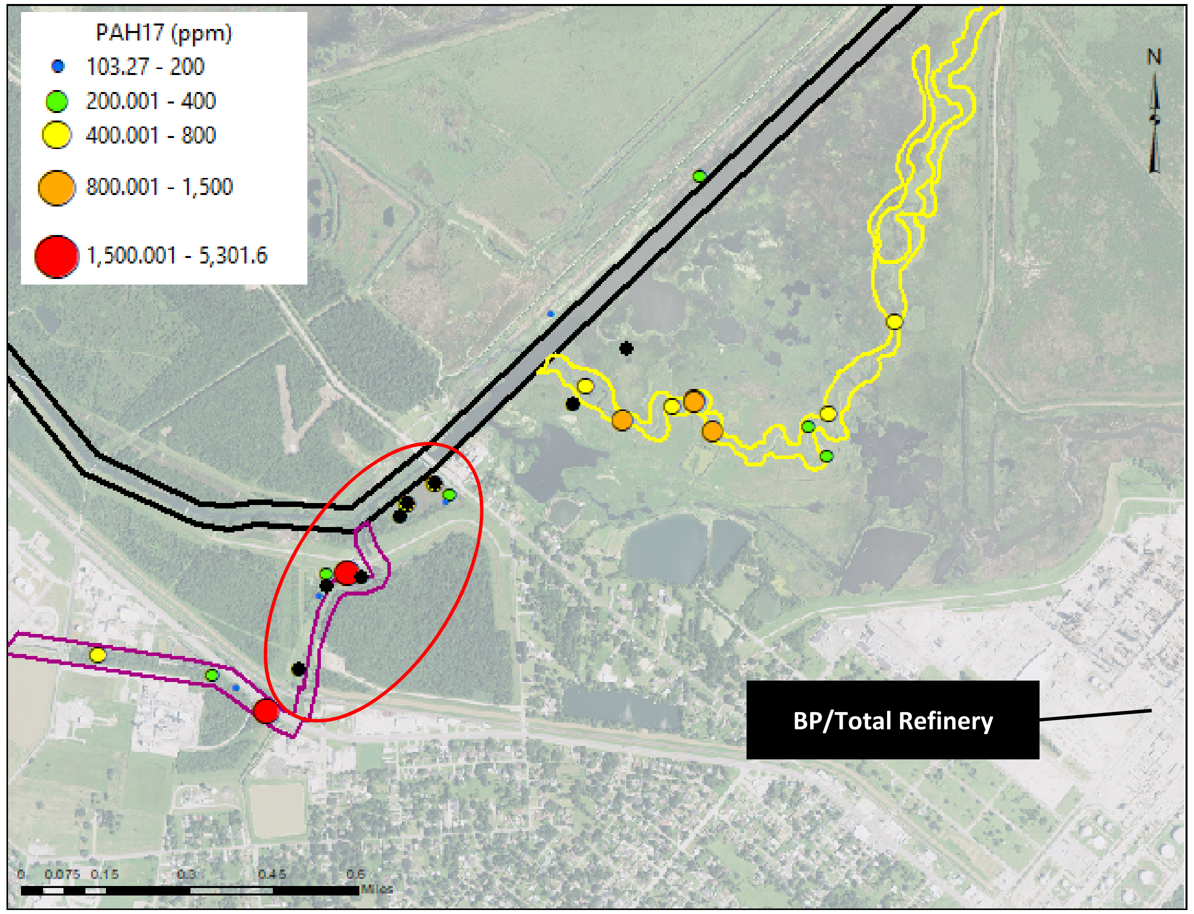


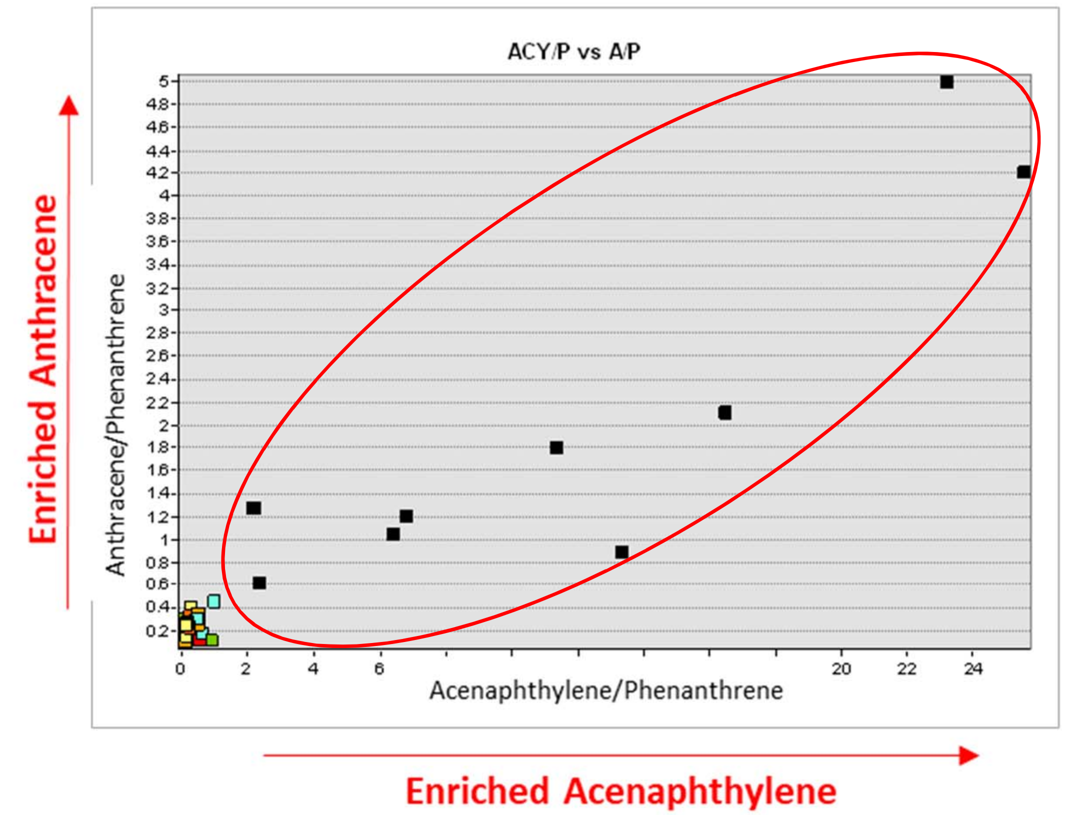


Intermediate molecular weight PAH-dominant samples found primarily in Molasses Bayou

PAH composed of intermediate weight PAH found primarily in Molasses Bayou.

Figure 27: Distinct Differences in PAH Composition Reconcile with Geography and Thus Likely Sources

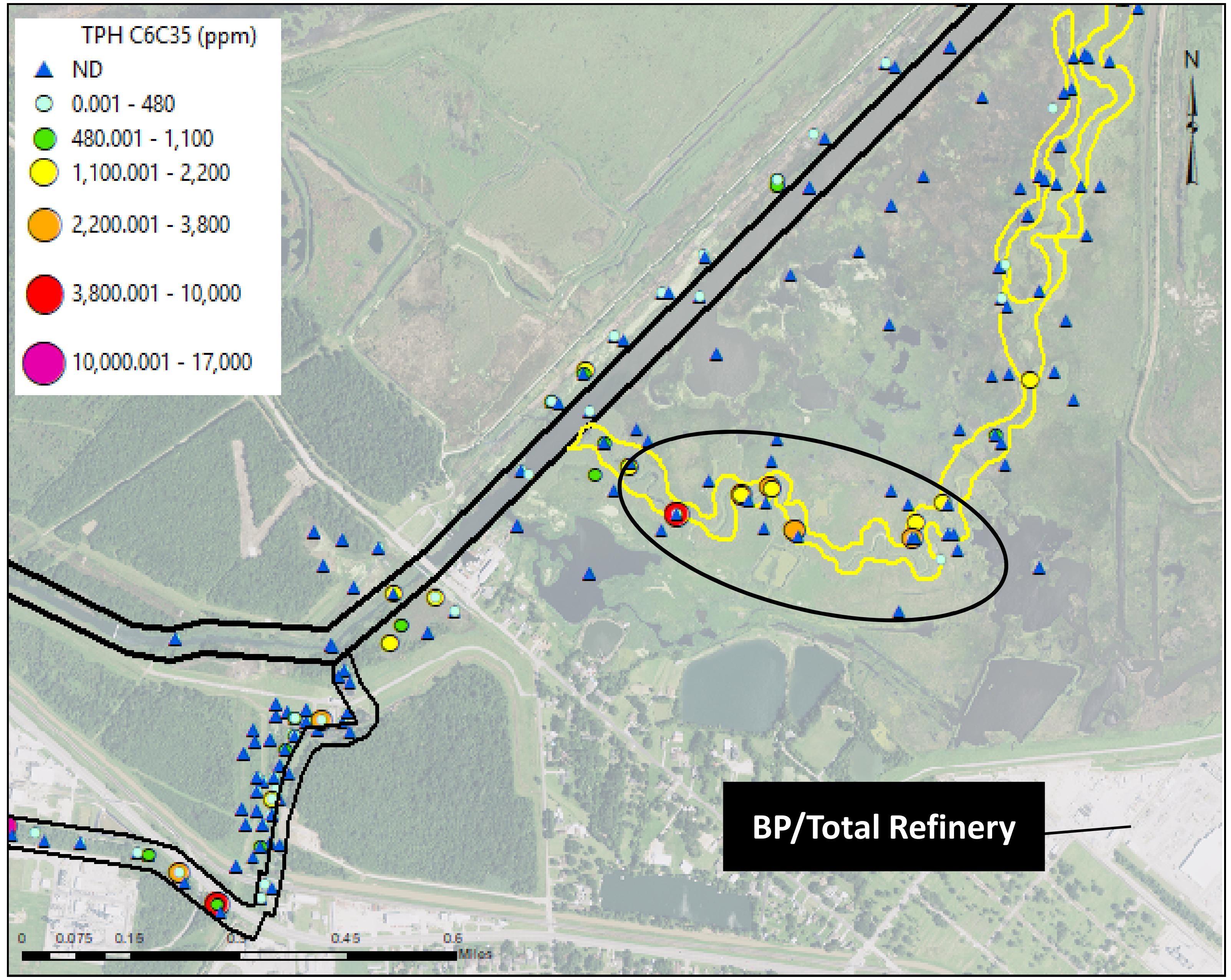




Black dot = location of Acenaphthylene, Anthracene enriched samples

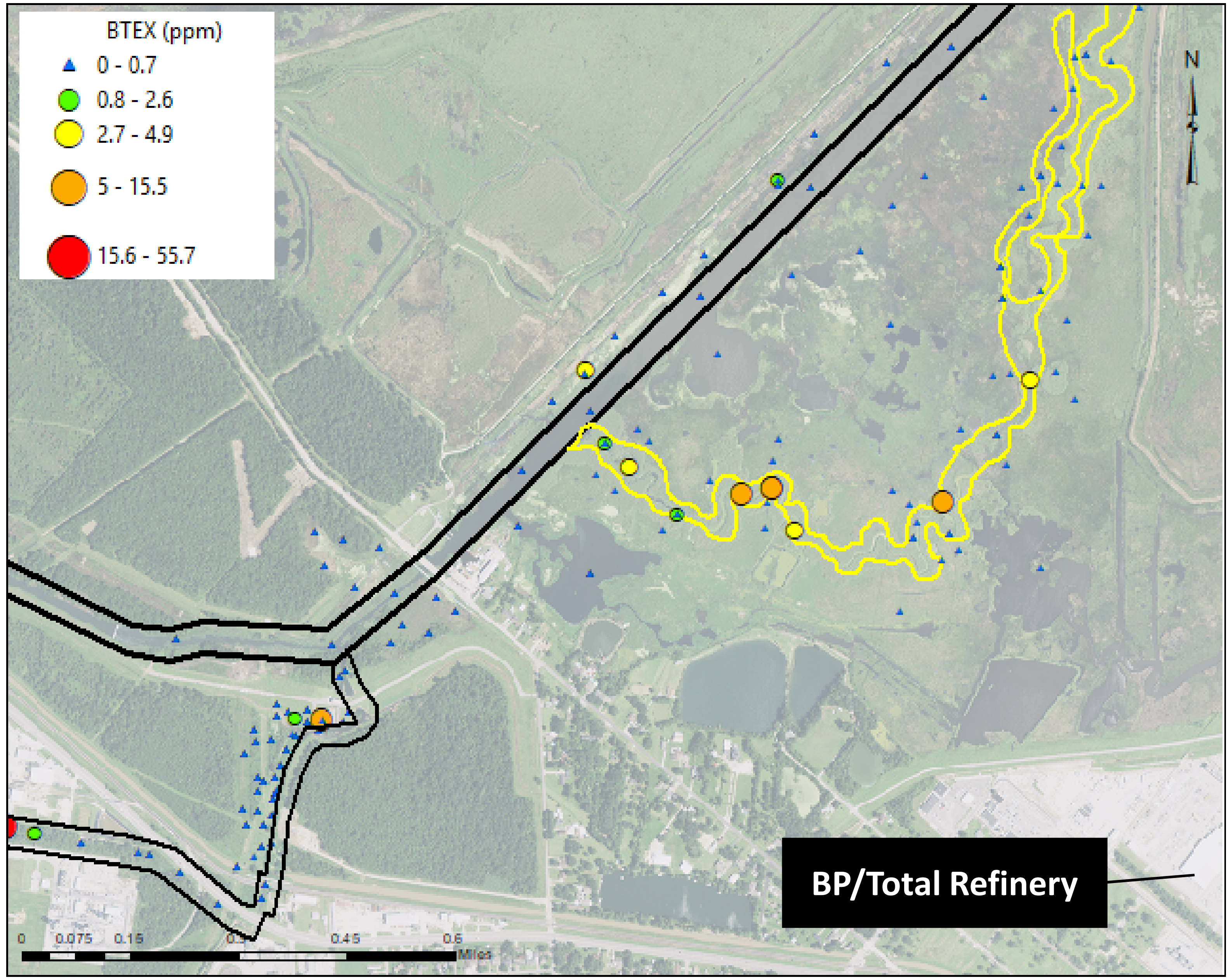
Distinct molecular differences in PAH composition are evident between samples in Jefferson Canal AOI and Former Star Lake AOI and those in Molasses Bayou.

Figure 28: Acenaphthylene-enriched PAH Found Primarily in Jefferson Canal AOI, Jefferson Canal Spoil Pile AOI, and Former Star Lake AOI



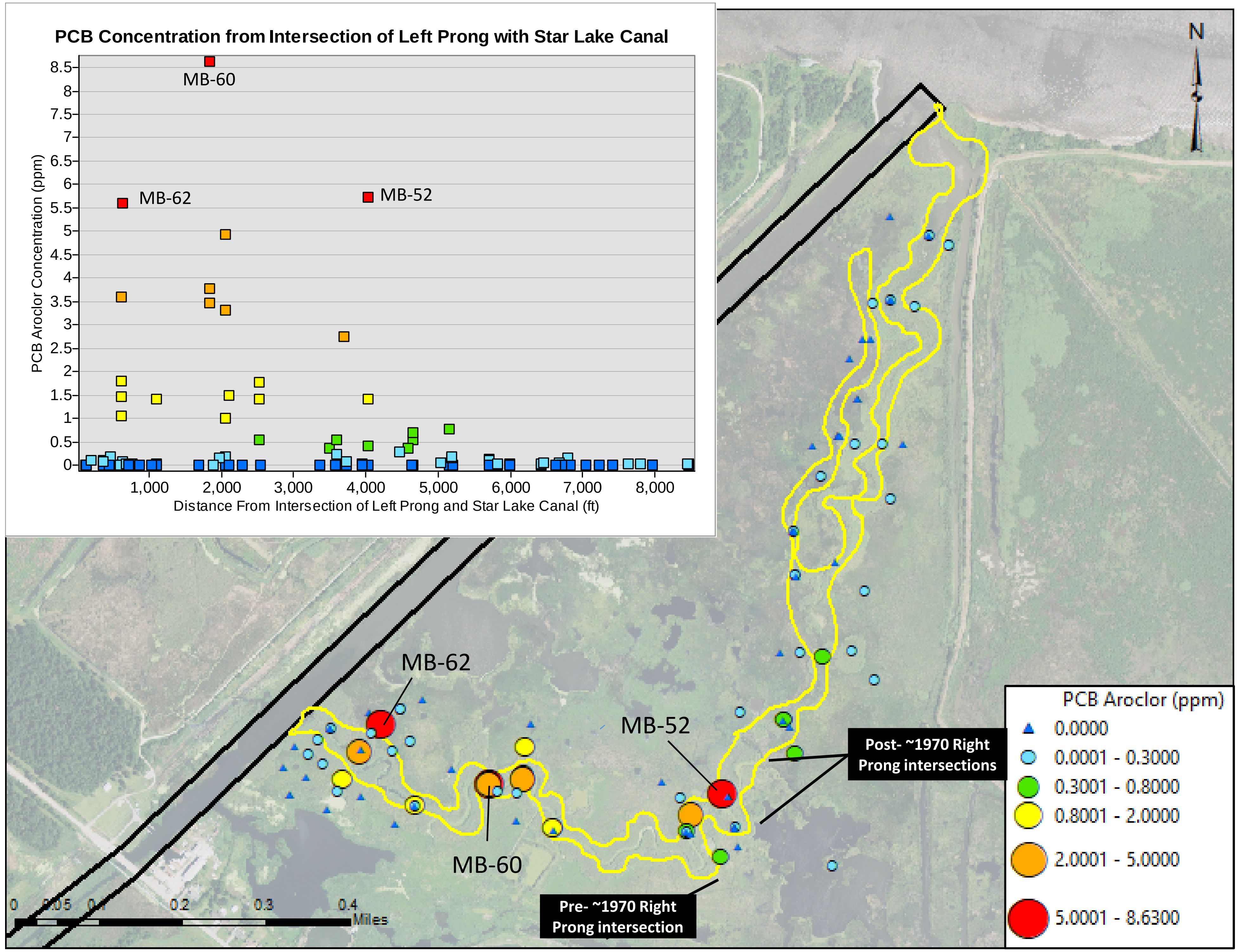
This feature is consistent with petroleum inputs to the Bayou.

Figure 29: Site Sediment Concentrations of Total Petroleum Hydrocarbons (TPH) are Elevated in Molasses Bayou



These data are consistent with the presence of petroleum. Because BTEX are relatively ephemeral in sediments, the presence of BTEX indicates likely recent inputs of petroleum to Molasses Bayou.

Figure 30: Site Concentrations of Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX) are Elevated in Molasses Bayou



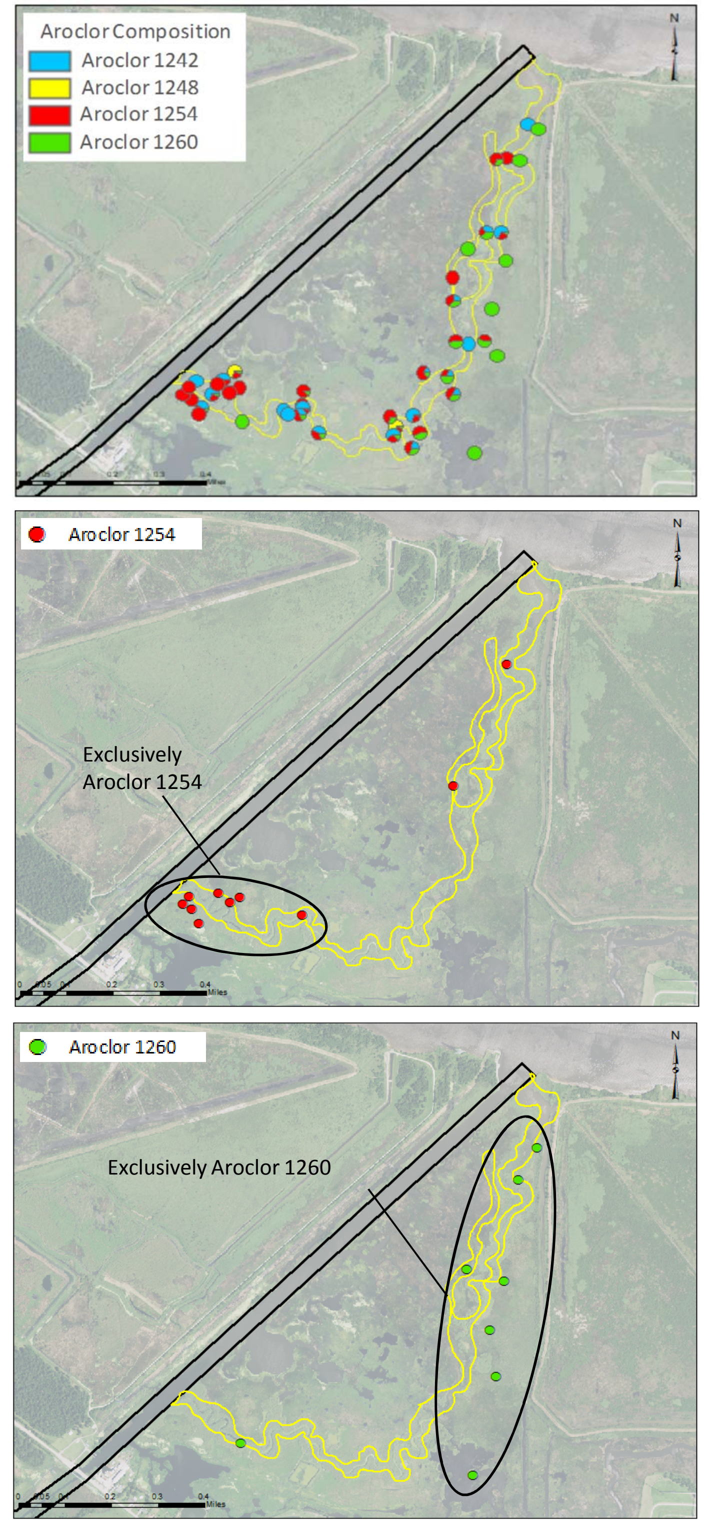
Elevated Total PCB Aroclor concentrations are observed along the Left Prong, including near the historic confluences of the Right Prong.

Figure 31: Site Concentrations of Total PCB Aroclors in Molasses Bayou

a)

b)

c)



a) Varied Aroclor composition among Left Prong sediments.
b) Sediments containing exclusively Aroclor 1254.
c) Sediments containing exclusively Aroclor 1260.

Figure 32: Spatial Differences in PCB Aroclor Composition in the Left Prong of Molasses Bayou is Consistent with the Right Prong as a Source of PCB to the Waterway.

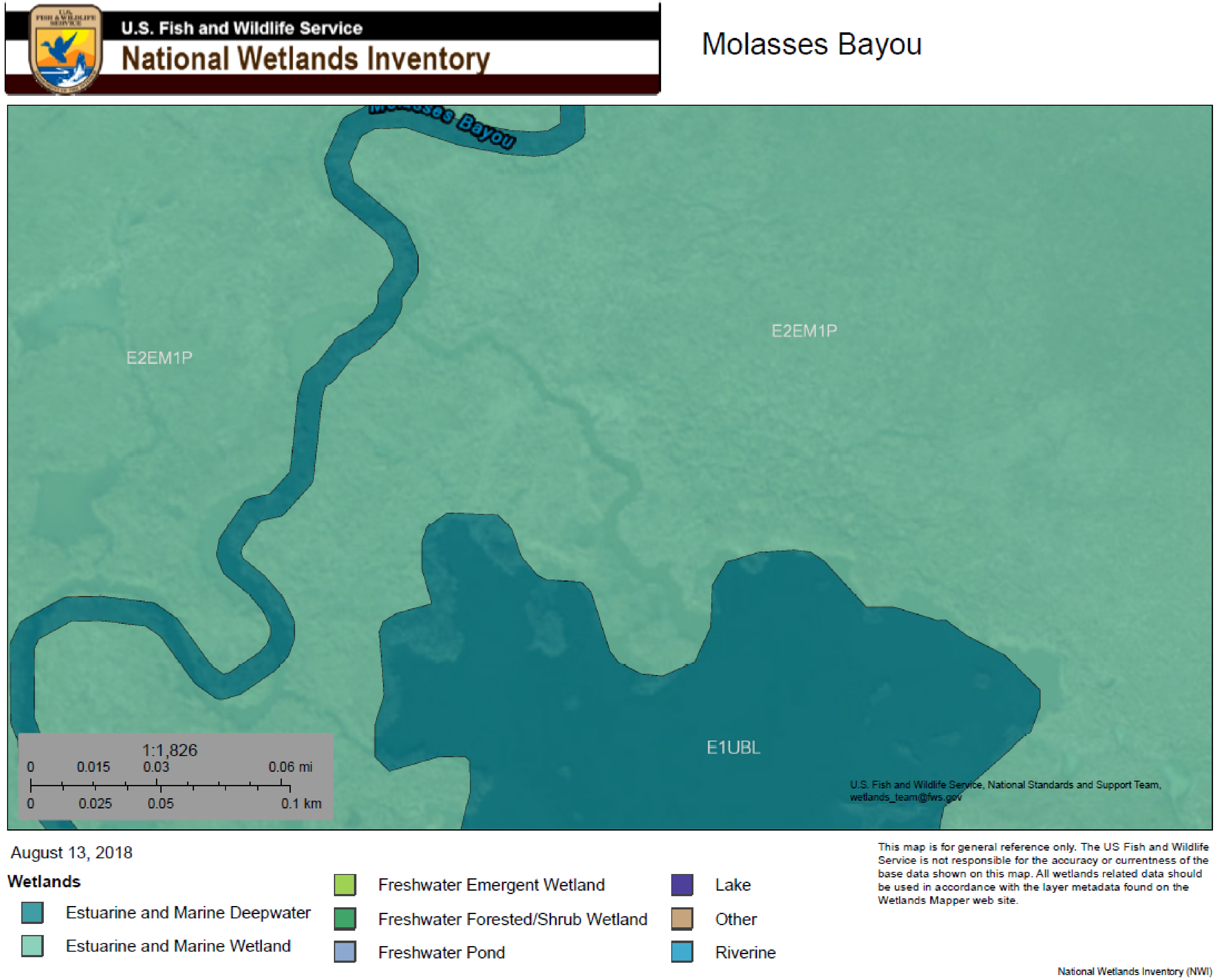


Figure 33: National Wetlands Inventory Map